INSTRUCTION MANUAL

MODEL 125

LIN-LOG/MULTIGENERATOR

Copyright © 1971
EXACT ELECTRONICS, INC.
All rights reserved
PRINTED IN U.S.A.
PATENT PENDING

EXACT® electronics, inc.
A Subsidiary of
Danalab, Inc.

Box 160 Hillsboro, Oregon
97123 Tel. (503) 648-6661
TWX 910-460-8811

IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

CONTENTS

SECTION 1	SPECIFICATIONS AND VERIFICATION OF SPECIFICATIONS PROCEDURE
SECTION 2	OPERATING INSTRUCTIONS
SECTION 3	CIRCUIT DESCRIPTION
SECTION 4	CALIBRATION PROCEDURE
SECTION 5	PARTS LIST
SECTION 6	PARTS OVERLAY AND SCHEMATICS
SECTION 7	ADDENDA

SECTION I

SPECIFICATIONS

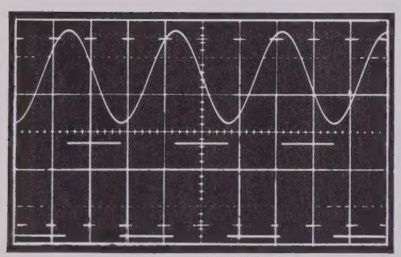
AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

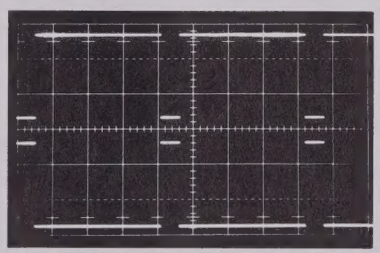
MODEL 125 LIN-LOG/MULTIGENERATOR

FEATURES

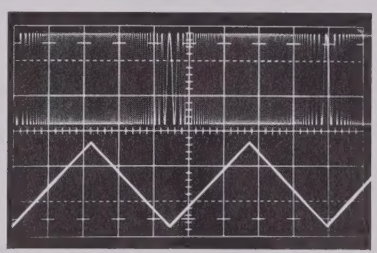
- WAVEFORM GENERATOR — SINE, SQUARE, TRIANGLE, RAMP, ±PULSE, ±SINE
- SWEEP GENERATOR, (1000:1 RANGE) LINEAR OR LOG
- PULSE GENERATOR — VARIABLE WIDTH AND REPETITION RATE
- TONE BURST GENERATOR
- GATE/TRIGGER
- VARIABLE PHASE START/STOP
- KELVIN-VARLEY DIVIDER FREQUENCY CONTROL
- VARIABLE D.C. OFFSET
- SEARCH MODE FOR MANUALLY SWEEPING OVER THREE DECADES
- FLOATING OUTPUT PROVISION
- 2 OUTPUT AMPLIFIERS WITH 80db ATTENS IN 10db STEPS



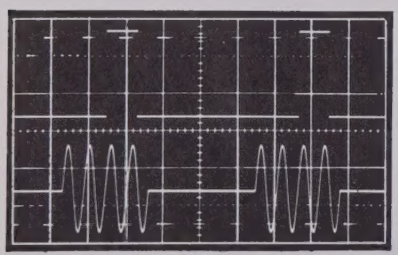
SINE — SQUARE



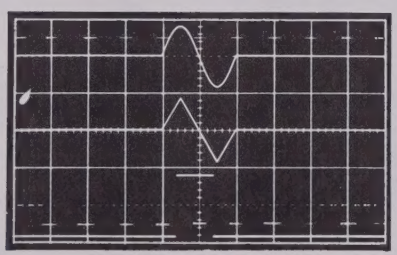
NEGATIVE AND POSITIVE PULSE



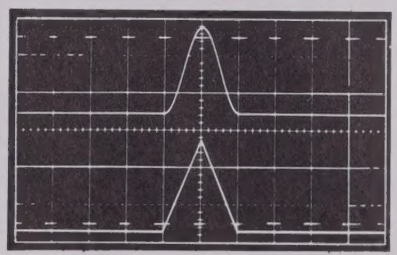
SWEEPING with INTERNAL TRIANGLE



PULSE and BURST MODES



SINGLE SHOT



HAVERSINE — HAVERTRIANGLE

® Box 160 Hillsboro, Oregon
97123 Tel. (503) 648-6661
TWX 910-460-8811
EXACT electronics, inc.

A Subsidiary of
Danalab, Inc.

GENERAL

The Model 125 is two generators with two complete power amplifiers in one small unique package. The main generator is a VCF (voltage controlled frequency) generator, producing sine, square, triangle, ±square, ±pulse, ±sine and sync waveforms over a dynamic frequency range of 0.1Hz to 5MHz. The pulse/burst/sweep generator is a triangle generator providing a linear triangle with a frequency of 0.1Hz to 1MHz. It is used to internally sweep the main generator over 1000:1 (three decade) range Linearly or Logarithmically or to gate or trigger the main generator for tone-burst and pulse generator operation.

A search mode is provided using the Kelvin-Varley frequency multiplier vernier, so the main generator can also be manually swept over three decades. In the pulse mode, pulse duration as well as repetition rate are variable. The main generator can also be manually or externally gated or triggered.

The pulse/burst/sweep square wave output is available at the output connector on the rear panel and the pulse/burst/sweep triangle is available at both output amplifiers. The main generator is swept up and down linearly in frequency by the pulse/burst/sweep generator in the sweep mode. Both output amplifiers have independent 80db step attenuators in 10db steps and ±10V of variable D.C. offset.

The Model 124 is actually a combination SINE, SQUARE, TRIANGLE, VCF, LINEAR OR LOG SWEEP, TONE-BURST, PULSE GENERATOR in one versatile package.

SPECIFICATIONS

WAVEFORMS
Sine, Square, Triangle, Positive Pulse, Negative Pulse, Positive Square, Negative Square, Positive Sine, Negative Sine, Sync, PBS TRI.

DYNAMIC FREQUENCY RANGE
Main generator, 0.1Hz to 5MHz. (20 Hz to 20KHz in the 20K Range).
Pulse/Burst/Sweep generator 0.1Hz to 1MHz.

MODES OF OPERATION
Run, Gate, Trigger, Pulse, Burst, Linear Sweep, Log Sweep

SYNC OUTPUTS
Main generator, square wave approximately 2V P-P open circuit. Approximately 100Ω output impedance.
Pulse/Burst/Sweep generator, square pulse approximately 100Ω output impedance. Leading and trailing edges concident with the peaks of the Pulse/Burst/Sweep Triangle. Located on rear panel.

OUTPUT:
V:f (voltage proportional to frequency): V:f output voltage directly related to frequency within selected range. Approx. 5mv to 5V for 1000:1 range.

FREQUENCY ACCURACY
Main generator, ±2% of frequency range (typically ±2% of setting).
Pulse/Burst/Sweep generator: 0.1Hz to 1MHz in four calibrated steps. Accurate within ±5%. Uncalibrated continuously variable between steps: variable has 100:1 range, down from calibrated step.

AMPLIFIER 1 OUTPUT
50Ω output impedance. All waveforms 20V P-P open circuit. 10V P-P into 50Ω with exception of Positive and Negative Square, Positive Sine and neg. (PBS) Tri. which are 10V peak open circuit, 5V peak into 50Ω. A full 80db of attenuation is provided in 10db steps with 20db continuously variable.

AMPLIFIER 2 OUTPUT
50Ω output impedance. All waveforms 20V P-P open circuit. 10V P-P into 50Ω with exception of Positive and Negative Square, Negative Sine and Pos. (PBS) Tri. which are 10V peak open circuit, 5V peak into 50Ω. A full 80db of attenuation is provided in 10db steps with 20db continuously variable. Amplifier 2 output is 180 degrees out of phase with Amplifier 1.

GATE AND TRIGGER MODES
Input: D.C. coupled, input impedance approximately 5K. Trigger and gate signal requirements, manual or external voltage of approximately 1.2 V for turn on. TTL compatible.

SINE WAVEFORM DISTORTION
<0.5% 0.1Hz to 100KHz (typically <0.2%).
No harmonics. <30db down 100KHz to 5MHz (typically 38 to 42db down).

SINE FREQUENCY RESPONSE
0.1db to 100KHz, 0.5db to 5MHz.

SQUARE WAVEFORMS
Rise and fall <50 nanoseconds.
Overshoot and ringing <5%.

TRIANGLE LINEARITY
99% to 100KHz, 95% to 5MHz.

D.C. OFFSETS: Variable ±5 into 50Ω, ±10V open circuit. D.C. offset plus signal cannot exceed maximum voltage output or clipping will occur.

FREQUENCY STABILITY
0.05% of setting for 10 min.,
0.25% of setting for 24 hrs.

AMPLITUDE STABILITY
0.05% of maximum P-P amplitude for 10 min.,
0.25% of maximum P-P amplitude for 24 hrs.

SYMMETRY (time): ±1%

POWER REQUIREMENTS
Input Voltage — 115% VAC ±10% or 230 VAC ±10%
Frequency — 50 to 400Hz.
Power Consumption — approximately 20W.

PHYSICAL CHARACTERISTICS
12½" wide x 3½" high x 10½" deep. Top and bottom covers are easily removable, exposing all calibration and circuit board areas.

PRICE:
Option "B" $50 — 0.01Hz-5MHz. Replace 20K range.

NOTE: (unless otherwise stated). Specifications apply 10% to maximum output voltage with instrument terminated into 50Ω and do not apply in the Search Mode or 20K range Specifications are valid at 25°C ±5°C warmup-time of 30 min.

® Box 160 Hillsboro, Oregon
97123 Tel. (503) 648-6661
TWX 910-460-8811
EXACT electronics, inc.
A Subsidiary of
Danalab, Inc.

Printed in U.S.A. 11/72

VERIFICATION OF SPECIFICATIONS

Following is a list of test equipment required to validate the specifications.

Test equipment with accuracy equal to the following list of test equipment will be acceptable for specification validation.

Oscilloscope, DC to 50MHz
Plug-In, Differential 20mv/cm sensitivity
Counter/Timer, .1μsec time base
DVM, .01% accuracy
Harmonic Distortion Analyzer, less than 0.1% residual distortion
Spectrum Analyzer, 1KHz to 100MHz

If for any reason the Model 125 generator fails to meet any specifications, it is recommended that the instrument be completely calibrated using the Calibration Instructions contained within this manual.

NOTE: Allow 30 minutes for warm-up.

FREQUENCY ACCURACY:

Main Generator:

1. Set controls as follows:

RANGE	1K
MULTIPLIER	1.0
MODE	RUN
AMP 1, AMP 2	TRI
ATTENUATORS Amp 1, Amp 2	OFF (OUT)
AMPLITUDE Amp 1, Amp 2	MAX
D.C. OFFSET Amp 1, Amp 2	OFF
P/B/S	10KHz
100:1 VAR	CAL

2. Connect the Counter/Timer to the Sync Output jack on the front panel with an appropriate coaxial cable to the A.C. input.

3. Observe time interval on counter of 1000μsec ±20μsec.

4. Set Range to 100. Observe time interval of 10msec ± .2msec.

FREQUENCY ACCURACY, Main Generator (Continued)

5. Set Range to 10. Observe time interval of 100msec ±2msec.
6. Set Range to 1. Observe time interval of 1000msec ±20msec.
7. Set Multiplier to .10. Observe time interval between 8.33sec and 12.50sec.
8. Set Range to 10. Observe time interval between 833msec and 1250msec.
9. Set Range to 100. Observe time interval between 83.3msec and 125msec.
10. Set Range to 1K. Observe time interval between 8.33msec and 12.5msec.
11. Set Range to 10K. Observe frequency of 1KHz ±200Hz.
12. Set Range to 100K. Observe frequency of 10KHz ±2KHz.
13. Set Range to 1M. Observe frequency of 100KHz ±20KHz.
14. Set Range to 3M. Observe frequency of 500KHz ±100KHz.
15. Set Multiplier to 1.0. Observe frequency of 5MHz ±100KHz.
16. Set Range to 1M. Observe frequency of 1MHz ±20KHz.
17. Set Range to 100K. Observe frequency of 100KHz ±2KHz.
18. Set Range to 10K. Observe frequency of 10KHz ± .2KHz.
19. Set Range to 1K. Observe frequency of 1KHz ±20Hz.
20. Set Multiplier to .50. Observe frequency of 500Hz ±20Hz.
21. Set Multiplier to 1.0.
22. Set range to 20K. Observe frequency of 20KHz ±400Hz.

Pulse/Burst/Sweep Generator

1. Connect the Counter/Timer to the P/B/S Sync Output on rear panel with an appropriate coaxial cable to the AC input.
2. Set 100:1 VAR to CAL position.
3. Set P/B/S to 1MHz. Observe frequency of 1MHz ±50KHz.
4. Set P/B/S to 10KHz. Observe frequency of 10KHz ±500Hz.
5. Set P/B/S to 100Hz. Observe period of 10ms ± .5ms.

FREQUENCY ACCURACY, Pulse/Burst/Sweep Generator (Continued)

6. Set 100:1 VAR full CCW. Observe period >1sec.
7. Set P/B/S to 10KHz. Observe period >10ms.
8. Set P/B/S to 1MHz. Observe frequency <10KHz.
9. Set 100:1 VAR to CAL and P/B/S to 10KHz.

TIME SYMMETRY

1. Connect the Counter/Timer to the Sync output jack on the front panel.
2. Set Range to 10K.
3. Set Multiplier to 1.0.
4. Set Counter/Timer to read time interval A to B and B to A. Observe time symmetry error < 1%.
5. Set Range to 1K. Observe time symmetry error < 1%.
6. Set Range to 100. Observe time symmetry error < 1%.
7. Set Range to 10. Observe time symmetry error < 1%.
8. Set Range to 1. Observe time symmetry error < 1%.
9. Set Multiplier to .10. Observe time symmetry error <1%.
10. Set Range to 1K.
11. Set Multiplier to 1.0.

FREQUENCY STABILITY

1. Observe that the frequency remains within 0.05% for 10 minutes or ± .5μsec.

SYNC OUTPUT

1. Connect oscilloscope to the Sync output on front panel with an appropriate coaxial lead.
2. Observe square wave of approximately 2V P-P open circuit.
3. Connect oscilloscope to the P/B/S Sync output on rear panel.
4. Observe Sync pulse approximately 2V P-P open circuit.

SECTION I SPECIFICATIONS

MAIN OUTPUT

AMP I

1. Set amplitude to MAX. Connect the main output to the oscilloscope with a 50Ω coaxial cable terminated into 50Ω.

2. Observe Tri >10V P-P.

3. Switch through square, triangle and sine waveform, observing >10V P-P amplitude.

4. Switch to negative square, positive square, + sine and -PBS, observing >5V peak amplitude.

5. Remove 50Ω terminator and observe >20V P-P open circuit for square, triangle and sine waveforms and >10V peak for positive and negative square, + sine and -PBS.

6. Add 50Ω terminator, set attenuator 10db, 20db, 30db, 40db, 50db and 60db and observe corresponding attenuation.

7. Rotate amplitude vernier and observe another 20db of attenuation.

8. Set amplitude to MAX, attenuator to 0db.

AMP 2

1. Set amplitude to MAX. Connect the main output to the oscilloscope with a 50Ω coaxial cable terminated into 50Ω.

2. Observe Tri >10V P-P.

3. Switch through square, triangle and sine waveform, observing >10V P-P amplitude.

4. Switch to negative square, positive square, - sine and +PBS, observing >5V peak amplitude.

5. Remove 50Ω terminator and observe >20V P-P open circuit for square, triangle and sine waveforms and >10V peak for positive and negative square, - sine and +PBS.

6. Add 50Ω terminator, set attenuator 10db, 20db, 30db, 40db, 50db and 60db and observe corresponding attenuation.

7. Rotate amplitude vernier and observe another 20db of attenuation.

8. Set amplitude to MAX, attenuator to 0db.

GATE AND TRIGGER MODES

1. Set:

   MODE GATE
   START LEVEL ~0~

2. Monitor Amp I output with oscilloscope.

3. Apply signal at Trig input jack, increase signal and observe main generator runs at approximately 1.2V of signal.

4. Depress Manual pushbutton and observe generator runs when button is depressed.

5. Set:

   MODE TRIGGER

   Apply signal at trigger input. Increase signal and observe main generator produces one complete cycle when trigger input rises to approximately 1.2V.

6. Depress Manual pushbutton and observe one complete cycle each time the Manual pushbutton is depressed.

SINE WAVE DISTORTION

1. Set:

   MODE RUN
   RANGE 10K
   AMPLITUDE MID RANGE
   Amp 1, Amp 2
   FUNCTION SINE
   Amp 1, Amp 2

2. Connect distortion analyzer to the Amp I output jack terminated into 50Ω. Measure sine distortion of <.5%, typically .2%.

3. Set Range to 100K and measure sine distortion <.5%.

4. Set Range to 5M. Connect spectrum analyzer to main output jack and measure harmonic content. Observe no harmonics <30db down.

5. Repeat above steps for Amp 2.

SINE FREQUENCY RESPONSE

1. Set Range to 10K.

SINE FREQUENCY RESPONSE (Continued)

2. Connect oscilloscope to Amp I output jack terminated into 50Ω.

3. Observe sine wave amplitude.

4. Set Range to 100K. Observe sine amplitude drop <.1db.

5. Set Range to 5M. Observe sine amplitude drop <.5db.

SQUARE WAVEFORM

1. Set:

RANGE	1M
FUNCTION	SQUARE
Amp 1, Amp 2	

2. Connect Amp I or Amp 2 output through a 50Ω coaxial cable terminated into 50Ω to the oscilloscope.

3. Observe risetime and falltime of square < 50ns at main output.

4. Observe overshoot and ringing < 5% of P-P amplitude.

D.C. OFFSET - Amp I and Amp 2

1. Set Range to 1K, amplitude vernier to MIN.

2. Rotate D.C. offset switch and observe D.C. level shift ±5V into 50Ω.

3. Remove terminator and observe D.C. level shift ±10V.

NOTE: D.C. offset plus signal cannot exceed maximum voltage output or clipping will occur.

AMPLITUDE STABILITY

1. Set amplitude to MAX, D.C. offset to OFF, function to TRIANGLE.

2. Connect Amp I main output through a 50Ω coaxial cable terminated into 50Ω.

3. Set plug-in sensitivity to 20mv/cm.

4. Measure accurately the positive peak of triangle and negative peak of triangle and record.

5. Wait 10 minutes and measure positive and negative peaks again. Observe amplitude change <10mv.

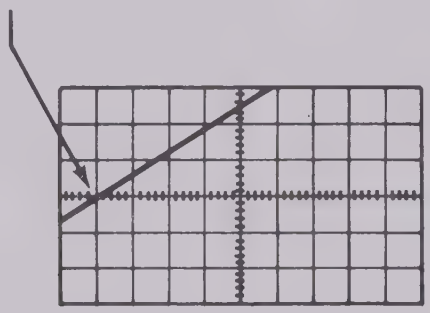
TRIANGLE LINEARITY

1. Connect Amp I output to the differential plug-in through a 50Ω coaxial cable terminated into 50Ω.

2. Adjust oscilloscope to obtain one-half cycle of triangle across full horizontal grid on oscilloscope CRT.

3. Set differential plug-in sensitivity at 20mv/cm.

4. Adjust comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below:



5. Record reference voltage using DVM accurate to Imv.

6. Adjust comparison voltage until slope of triangle intersects next major horizontal grid mark.

7. Record accurately the new reference voltage.

8. Repeat to obtain as many points as desired.

9. Calculate linearity and observe linearity is 99% or better.

SECTION 2

OPERATING INSTRUCTIONS

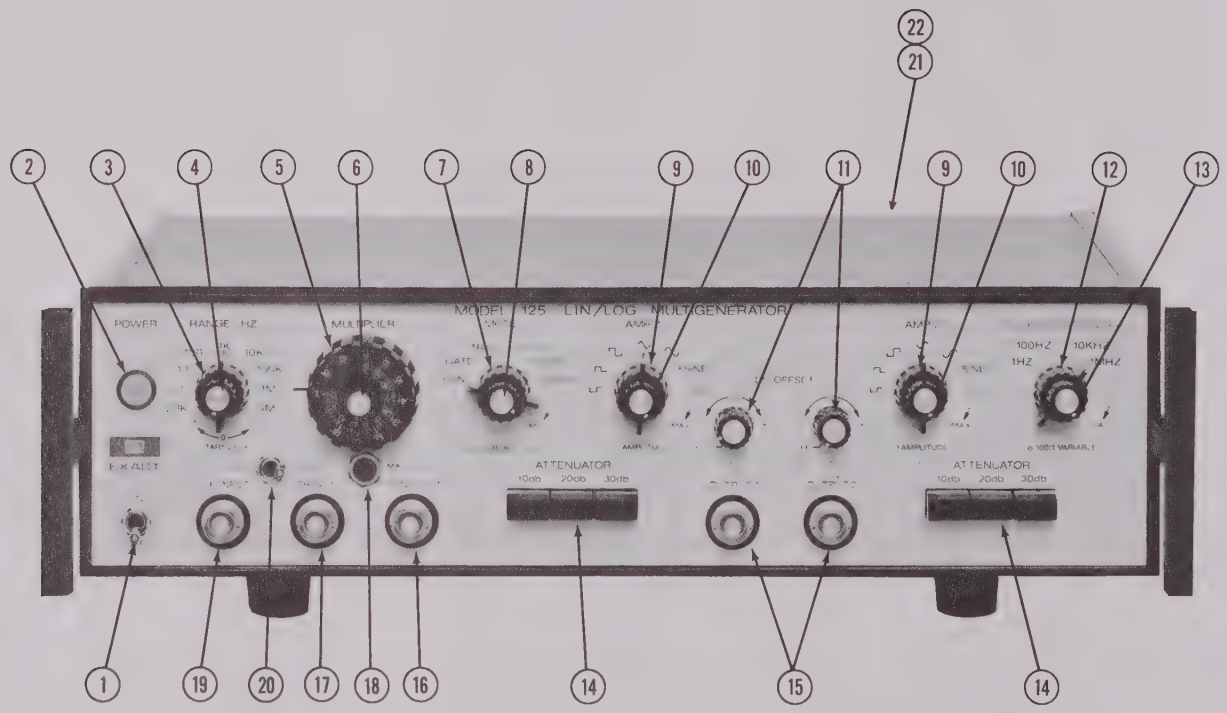


FIGURE 2.1.2
FRONT PANEL MODEL 125

2.1.0 FRONT PANEL FAMILIARITY (Figure 2.1.2)

1. Power Switch - Turns instrument On and Off.
2. Power Indicator Lamp - Visual indication when power is On.
3. Range Switch - Selects desired frequency range.
4. Start Level - Varies the lockout level or phase of the triangle and sine waveforms with respect to the square wave.
5. Multiplier Dial - Provides calibrated fixed steps between range settings. Each step equals 10% of range. The "S" position places the generator in the Search mode.
6. Multiplier Vernier - Allows variable adjustment of frequency between fixed steps of the Multiplier dial.
7. Mode Switch - Selects main generator modes of operation.
8. Sweep/Burst Width - Controls sweep width in sweep mode and burst width in burst mode.
9. Function Switch, Amp 1 and Amp 2 - Selects the desired function.
10. Amplitude, Amp 1 and Amp 2 - Provides 20db variable attenuation of the output amplitude.
11. D.C. Offset Switch - The Off position disables the offset potentiometer. The offset potentiometer manually adjusts the D.C. reference of the output waveform selected by the Function switch.
12. Pulse/Burst/Sweep Switch - Selects desired frequency of Pulse/Burst/Sweep Generator.
13. 100:1 VAR - Provides 100:1 variable frequency to cover all frequencies between ranges.
14. Attenuator, Amp 1 and Amp 2 - Selects desired amount of attenuation at Amp 1 or Amp 2 outputs. Pushbutton attenuators provide 10db steps (adding) to 60db.
15. Output Jack, Amp 1 and Amp 2 - 50Ω output jack for all waveforms selected by the Function switch.
16. Sync Out - Provides Sync pulse for external equipment. Sync pulse is coincident with internal square wave.
17. Trig In - Provides input for external gating and triggering signals for the main generator.
18. Manual Pushbutton - Provides manual gating and triggering signal.
19. VCF Input - Provides external input for voltage control of frequency or sweeping.
20. Log/Lin Switch - Selects lin or exponential control of frequency from VCF input or internal sweep.

FRONT PANEL FAMILIARITY (Continued)

21. P/B/S Sync - Provides a sync pulse coincident with peaks of P/B/S triangle.

22. V:f - Provides approx. 0 to 5V proportional to main generator frequency for use with frequency meter, etc.

2.2.0 FIRST TIME OPERATION

NOTE: Before applying power to the instrument, the input power line switch must be in the proper position corresponding to the line voltage source which will be applied. The instrument comes supplied with the proper fuse for 117V operation. If the unit is to operated from 230V AC line, place the line switch located on the rear panel to the 230V position and change the fuse as indicated by the fuse date silkscreened on the rear panel.

Plug the power cord into the proper source of 117V AC or 230V AC 50-400Hz and turn on the power switch.

NOTE: This instrument is equipped with a floating circuit ground which may be tied to the chassis ground or floated to some other source by removal of the grounding strap on the rear panel. It is recommended that the rear panel chassis ground and circuit ground be connected together with the grounding strap provided unless it is necessary to float the instrument ground.

Set controls as follows:

RANGE	10K
MULTIPLIER	1.0
MODE	RUN
FUNCTION	~
Amp 1 and Amp 2	
AMPLITUDE	MAX
Amp 1 and Amp 2	
ATTENUATOR	0db (OFF)
Amp 1 and Amp 2	
D.C. OFFSET	OFF
P/B/S	10KHz
100:1 VAR	CAL

1. Connect the main output through a 50Ω coaxial cable into a 50Ω terminator to a suitable oscilloscope. A 10KHz 10V P-P triangle waveform should be observed under these conditions.

2. Switch the Function switch through its various output waveforms.

3. The frequency may be selected by the Range switch and/or the Multiplier dial.

4. Switch the D.C. Offset switch On and observe the waveform D.C. level may be adjusted as desired.

NOTE: Reduce output amplitude while changing D.C. offset to prevent saturation of waveform.

2.2.0 (Continued)

5. Observe the output amplitude can be adjusted over its 80db of dynamic range by the Amplitude vernier and the pushbutton attenuator.

GATE MODE

6. Place the Mode switch in the Gate position. Observe the main generator is now locked out. Observe the output while depressing the Manual pushbutton. The generator will free run as long as the pushbutton is depressed.

7. Rotate the Start Level control and observe the lockout level may be adjusted to the desired level or phase.

NOTE: The generator will free run if the Start Level is rotated too far (> 90 degree phase shift).

TRIG MODE

8. Set the Main Mode switch to the Trig position. Observe one complete cycle each time the Manual pushbutton is depressed.

PULSE MODE

9. Set the Mode switch to Pulse.

Set controls as follows:

FUNCTION Amp 1 and Amp 2	SQUARE
RANGE	10K
MULTIPLIER	1.0
P/B/S	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPE	2 ms/cm

Trigger scope from rear panel P/B/S Sync output.

The generator is now being triggered by the P/B/S Generator, providing a pulse output.

Observe that the main generator Range and Multiplier controls vary the pulse width. The repetition rate is variable by varying the P/B/S frequency.

BURST MODE

10. Place the Mode switch to Burst. The main generator is now being gated by the P/B/S Generator, producing a burst (more than one cycle) at the output.

2.2.0 (Continued)

Set the generator controls as follows:

FUNCTION	SINE
RANGE	10K
MULTIPLIER	1.0
P/B/S	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPE	2 ms/cm

Trigger the scope from P/B/S Sync output on rear panel.

Observe by adjusting the Sweep/Burst width and P/B/S frequency the burst "on" and "off" time may be varied. The frequency of the main generator determines the frequency of each cycle in the Burst.

CAUTION: If the Sweep/Burst width is adjusted too narrow, the main generator will lock out.

SWEEP MODE

11. In the Sweep Mode, the P/B/S Tri is connected to the sweep input (VCF input) internally via the Sweep/Burst width potentiometer.

Set controls as follows:

MODE	SWEEP
RANGE	10K
MULTIPLIER	.10
AMP 1 and AMP 2	TRI
AMPLITUDE Amp 1 and Amp 2	MAX
D.C. OFFSET Amp 1 and Amp 2	OFF
PULSE/BURST/SWEEP	100Hz
100:1 VAR	FULL CCW (1Hz)
SWEEP/BURST WIDTH	MID RANGE

Observe the main generator triangle is being swept up in frequency from 1KHz and back to 1KHz following the Pulse/Burst/Sweep triangle.

Observe the sweep width change while adjusting the Sweep/Burst width control. Observe the sweep rate change while adjusting the P/B/S frequency.

NOTE: The main generator may be swept down in frequency by connecting the -PBS signal selected by Amp 2 externally to the VCF input and placing the Mode switch to the Gate position. The Amplitude setting of Amp 2 will control the sweep width, and the P/B/S Frequency will control the sweep rate. Repeat for log mode.

SECTION 3

CIRCUIT DESCRIPTION

3.1.0 BLOCK DIAGRAM (Figure 3.1.1)

MAIN GENERATOR

The Summing Amplifier sums the currents from the Multiplier dial, VCF input and internal sweep signal. The output of the Summing Amplifier drives the Positive and Negative current sources. A diode gate alternately connects the Positive and Negative constant current sources to the timing capacitor selected by the Range switch. This constant current charging and discharging the timing capacitors produces the required triangle. The Tri Buffer supplies the power to drive the associated circuitry without loading the current sources. Switching signal for the Diode Gate is supplied from the Bi-Stable switch in conjunction with the Level Detector. The Sync signal from the Level Detector and Bi-Stable switch is brought out through the Sync Output Buffer to prevent loading of the Bi-Stable switch.

The Lockout current source sinks the timing current from the current source during Gate, Trigger, Pulse and Burst Modes. Logic for these modes is obtained from the Main Generator Lockout Amplifier. The Reset Buffer supplies a signal from the Level Detector - Bi-Stable switch, needed for completion of last cycle and reset for the Logic Gate.

D.C. coupled gating and triggering is accomplished by the Trig Level Comparator. Signal from the Trig Level Comparator enables the Lockout Logic Gate during lockout modes. The Manual Gate and Trig switch serves to eliminate contact bounce of the Manual Pushbutton switch during manual triggering and gating to prevent multiple triggering. The triangle from the Tri Buffer is shaped by the Sine Converter and amplified by the Sine Amplifier to produce the sinewave.

All output waveforms pass through the Input Buffer and are then connected to the Output Amplifier. The Output Amplifier provides the necessary power to drive the Main Output. The pushbutton Output Attenuator provides 60db of attenuation in 10db steps.

P/B/S GENERATOR

The P/B/S Generator produces the required triangle waveform for internally sweeping, bursting and pulsing the Main Generator.

The P/B/S Integrator uses an operational amplifier as an integrator to convert a square wave to a linear triangle.

The Level Detector produces the required square wave in conjunction with the integrator. The P/B/S Sync Output Buffer prevents loading of the Level Detector from the P/B/S Sync Output.

3.2.0 CIRCUIT DESCRIPTION

3.2.1 POWER SUPPLY (Figure 6.2.1)

Line voltage is connected to transformer T100 through S101, a line voltage switch. This switch selects either the 117V or the 230V tap on the transformer. Full wave rectification

3.2.1 POWER SUPPLY (Continued)

is accomplished by D100 from the center tapped secondary. C101 and C102 provide ±23V filtering.

+12V SUPPLY

Q100 is a precision voltage regulator. The output is connected to series pass driver Q110 which supplies the necessary current for the +12V supply. The reference divider, R111, R112 and R113, is connected across the +12V supply. R112 adjusts the reference to the voltage regulator, establishing +12V at the output. Q100 is short circuit protected internally. Q100, pin 10, senses the output current through R110 and will turn off the +12V supply in the even of a short circuit of >500ma.

-12V SUPPLY

Q135 is an operational amplifier. The +12V is connected through R114 and -12V adjust R115 to the inverting input (pin 2). The output of Q135 is offset by Zener Diode D135 to keep the operational amplifier output level within safe limits. Q130 is an emitter follower which drives the series pass transistor (Q125). Feedback resistor R120 establishes the proper amount of negative feedback. Q120 senses the output current through R121 providing short circuit limiting at about 500ma.

+5V SUPPLY

The +5V supply is simply an emitter follower. R141 and R140 provide approximately +5.6V at Q150 base, establishing +5V at the emitter.

-7V SUPPLY

The -7V supply is also an emitter follower. R161 and R160 provide approximately -7.6V at Q170 base, establishing -7V at Q170 emitter.

3.2.2 SUMMING AMPLIFIER AND CURRENT SOURCES (Figure 6.2.2)

Q200 is an operational amplifier connected for a voltage gain of -1. The Main Multiplier dial (S200) forms a Kelvin-Varley Voltage Divider providing approximately +5V to +.5V to the Summing Amplifier Input (TP209). By varying the applied input voltage, the signal to the Constant Current Source Drivers can be varied, thus providing a method for changing the timing current and thus the frequency. The Summing Amplifier inverts the applied input voltage. When S200 (Mult) is in the Search Mode, the vernier (R210) is connected between +12V and ground to supply a 1000:1 voltage ratio, thus a 1000:1 frequency deviation. Main Timing Adjust (R207) establishes the correct input voltage to the Kelvin-Varley Divider to obtain the correct timing during calibration. D200 and D201 provide input protection for the μA709 operational amplifier. R201 (1000:1 Adj) provides input current to Q200 to adjust the 1000:1 range when multiplier is in search.

The VCF Input is connected to the Summing Amplifier at TP205, providing an external source of frequency control. By applying voltage at the VCF input, the frequency may be

3.2.2 SUMMING AMPLIFIER AND CURRENT SOURCES (Continued)

varied as with the Multiplier dial. The applied input voltage will add to or subtract from that established by the Multiplier dial setting. If the Multiplier dial is set at position 1.0, approximately +5V is applied to the input of the Summing Amplifier. If a positive voltage is now applied to the VCF Input Jack, the Summing Amplifier will saturate. If -5V is applied at the VCF Input Jack, this will add to the +5V applied by the Multiplier dial and the resultant input voltage will approach 0V, driving the Summing Amplifier output to approximately 1/1000 of the frequency of the Range and Multiplier setting. If the Multiplier dial were in the Search Mode of operation and set at approximately 0V input at TP209 by the Search vernier (R210), the frequency would be approximately 1/1000 of the Range setting. By applying +5V at the VCF Input Jack, the two voltages will sum, establishing approximately +5V at the Summing Amplifier input. This will cause the frequency to sweep up to approximately the frequency of the Range setting.

TP204 is the internal sweep input, connected to the P/B/S Generator when in the Sweep Mode of operation. The frequency may be swept up only when sweeping internally because the internal triangle is positive only with respect to ground. The P/B/S triangle is adjustable from +4V to 0V by the Sweep/Burst Width control to provide the desired amount of sweep. The VCF Balance (R229) compensates for the offset in the Summing Amplifier, establishing a 0V reference at the Summing Amplifier input. The output of the Summing Amplifier is approximately 0V to -5V and drives the Positive and Negative Current Source Drivers.

POSITIVE AND NEGATIVE CURRENT SOURCE DRIVERS

The output of the Summing Amplifier (0V to -5V) is connected to Q240, the Positive Current Source Driver, through R260B. Q255 and Q240 provide a constant current source in the feedback loop of the Positive Current Source Driver. Q240 will turn on Q255 until a feedback current equal to the input current through R260B is equalized. This current causes a voltage drop across R255A which equals the voltage drop across R260B.

The Search Sym Adj (R242) compensates for offset in the operational amplifier, establishing a 0V reference at Q240 input and balancing the two Current Source Drivers at 1000:1 to obtain correct symmetry at 1000:1.

Q250 in conjunction with Q260 make up the Negative Current Source Driver. The output signal from Q200 Summing Amplifier is connected to Q250 operational amplifier at the Non-Inverting Input. Q250 is connected as a voltage follower. Q260 establishes a constant current equal to the input voltage ÷R260A. This constant current causes a voltage drop equal to the output voltage of the Summing Amplifier, across R255B, exactly equal to and of opposite polarity of that across R255A.

POSITIVE AND NEGATIVE CONSTANT CURRENT SOURCE

Q275, Q280, Q285 and Q290 are the Positive and Negative Constant Current Sources providing the constant timing current to charge and discharge the timing capacitor. Q275 operational amplifier and Q280 FET are connected to form a constant current source.

3.2.2 POSITIVE AND NEGATIVE CONSTANT CURRENT SOURCE (Continued)

The signal across R255A is connected to Q275 operational amplifier at the non-inverting input. This causes a voltage of exactly the same polarity and amplitude across R276A timing resistor. This causes a constant current E(R276A) ÷ R(R276A) to charge the timing capacitor when the Diode Gate is turned on, connecting the Positive Current Source. The FET (Q280) prevents loading of the current sources at very low timing currents (1000:1).

Q285 operational amplifier and Q290 FET provide the negative constant current needed to charge the timing capacitor in exactly the same way. The 0.1Hz symmetry (R292) compensates for offset current in the operational amplifiers (Q285 and Q290) to establish the correct symmetry on slow timing ranges with large timing resistors. This adjustment is made on the 1Hz range at the .1 setting on the Multiplier Dial.

The Diode Gate is made up of D280, D281, D282 and D283. The timing capacitors are connected at TP330 through the Range Switch, which also switches the Timing resistors.

Gate switching signal is connected at D280 and D282 junction. When the Gate signal is positive, D282 is forward biased and sinks the timing current from the Negative Current Source, thus disconnecting the Negative Current Source. D280 is now reverse biased, allowing timing current to charge the timing capacitor through D281 from the Positive Current Source. When the Gate signal switches negative, D280 is forward biased, thus sinking the positive timing current through D280. D282 is now reverse biased, allowing timing current to charge the timing capacitor from the Negative Current Source through D283. D301 is connected to the Lockout Current Source and sinks the timing current during lockout.

TRIANGLE BUFFER

Q330A and B and Q340A and B serve as a unity gain, high input impedance buffer for the triangle generated at TP330. Q330A FET prevents loading of the current sources by its very high input impedance. Q330A is a source follower driving Q340A, an emitter follower. Q340B provides offset and temperature compensation for Q340A while Q330B provides offset and temperature compensation for Q330A.

LOCKOUT CURRENT SOURCE

The lockout current source consists of Q265 (operational amplifier) and Q270 (FET) connected as a current source. The lockout current source and the positive current source are both driven by the positive current source driver Q240 and Q255. R300, R301 and R302 provide twice the current as the positive and negative current source.

In the Run mode, D525 is forward biased and sinks the lockout current from the lockout current source, and reverse biases D300 and D301. During lockout, D525 is reverse biased. D300 connected to the start level amplifier will sink all the current from the lockout current source. When the timing capacitor charges negative, D301 will become forward biased when the timing capacitor reaches the voltage level established by the start level control D306 at D300 cathode. The timing capacitor will stop charging when D301 becomes

3.2.2 LOCKOUT CURRENT SOURCE (Continued)

forward biased and sinks the timing current from the negative current source. D300 will sink exactly the same current as D301. The current thru D300 and D301 will always be the same because the lockout current source supplies twice the timing current as the negative current source.

START LEVEL AMPLIFIER

The start level amplifier is a closed loop operational amplifier (Q300) with a gain slightly < 1/10. Q320 and Q325 buffer provides a very low output impedance necessary to drive lockout diode (D300). The output of the buffer will swing approximately ±1.4V depending upon the setting of the start level control R306. This setting determines the level at which the triangle will lock out.

3.2.3 LEVEL DETECTOR/BISTABLE SWITCH (Figure 6.2.3)

Level Detector/Bistable Switch Q400A, B, C is a differential amplifier used as a level detector. Q400C is a constant current source for differential amplifier Q400A and Q400B. The reference level at the base of Q400B is determined by one of the current sources connected by the diode gate, D403 - D406. D400 and D401 limit the collector swing of the differential amplifier to improve high frequency response. The Level Detector collectors drive a non-saturating current mode switch. The Bistable Switch is differential input and differential output. One output, Q430, Q435, drives the reference gate for the Level Detector, the Reset Buffer, the Sync Output Buffer and the Current Source Gate. R402 and R409 adjust the positive and negative trip points of the Level Detector, establishing the positive and negative peaks of the triangle. The other output, Q440, Q445, provides the square wave signals for the Output Amplifiers. The Norm Sq. Amp (TP459) is adjusted by R456 (+ sq. amp) and R461 (- sq. amp). The Neg. Sq. Amp (TP464) is adjusted by R463 (neg. sq. amp). Q430 and Q435 provide the Pos. Sq. at TP458. The Pos. Sq. Amp is adjusted by R450 (pos. sq. amp).

SYNC OUTPUT BUFFER

Q450 is an emitter follower which provides isolation while providing a sync pulse to the Sync Output Jack. The sync pulse is clipped by diodes D450 through D453.

3.2.4 LOCKOUT LOGIC (Figure 6.2.4)

TRIGGER LEVEL COMPARATOR

Q500 is a high speed differential comparator providing D.C. coupled Triggering, Gating and Bursting modes for the Main Generator Logic Gate.

Run Mode:

In the Run mode, +12V is applied to the inverting input of Q500 through S500A. This assures that the non-inverting input always remains more negative than the inverting input.

3.2.4 LOCKOUT LOGIC, Trigger Level Comparator (Continued)

This causes Q500 output to remain negative or in the Run mode of operation. The input of the comparator is protected by clipping diodes D500 and D501.

Gate Mode:

In the Gate mode, the +12V from S500A is disconnected, causing Q500 inverting input (pin 3) to go to a more negative state than the non-inverting input due to R509. This switches the output of the comparator to its positive or "1" state. The "1" from the comparator placed the Logic Gate in a lockout condition. The generator will remain in a lockout condition until signal is received at the comparator input (pin 2).

In the Gate mode, the comparator input is connected through S500B to the External Trigger Input. A signal >1.2V will cause the Trigger Level Comparator to switch, placing the Logic Gate in a "run" condition. When the input signal is removed or falls below 1.2V, the comparator will allow the Logic Gate to return to its lockout condition.

Trigger Mode:

The only difference between the Gate and Trigger modes of operation is that the output of the comparator is A.C. coupled to the logic Gate instead of D.C. coupled. When the trigger signal causes the comparator to switch, the negative output of the comparator A.C. couples a differentiated negative pulse into the Logic Gate, placing it in a "run" condition. The duration of this pulse is very short, allowing the Logic Gate input to return to a "1" or a lockout condition even though the comparator may still be "OFF" in its negative state. The square wave from the level detector (R454) will couple a "0" into the Logic Gate upon completion of the first cycle and cause the generator to lock out. The external trigger signal must be removed, allowing the comparator to reset before another pulse can be coupled into the Logic Gate. One complete cycle will be generated each time a signal >1.2V is applied at the Trigger Input.

Pulse Mode:

In the Pulse mode, the positive triangle from the P/B/S Generator is connected to the comparator input through S500B. The Pulse mode operates as in the Trigger mode. Each time the triangle waveform rises about 500mv, one complete cycle of the Main Generator will be completed. By adjusting the P/B/S frequency, the pulse repetition rate can be varied over an extremely wide range.

Burst Mode:

The Burst mode functions as in the Gate mode. The positive triangle is connected to the comparator input in the Burst mode. When the level of the triangle rises about 500mv, the comparator will switch, holding the Logic Gate in a "run" condition as long as the triangle remains >500mv. By adjusting the Sweep/Burst width and P/B/S frequency, the Burst width (on time) and Burst off time can be adjusted as desired.

3.2.4 LOCKOUT LOGIC, Trigger Level Comparator (Continued)

NOTE: When the Burst width period approaches the period of one cycle of the Main Generator, the generator will lock out until the Burst width period is adjusted wider than the period of one cycle of the Main Generator.

Sweep Mode:

In the Sweep mode, the generator is placed in a "run" condition by the +12V at S500A. All trigger signal input paths are disconnected. The P/B/S triangle is connected to the Summing Amplifier input (TP204) through S500B. This allows the Main Generator to be swept up in frequency. By adjusting the sweep width and P/B/S frequency, the sweep width and sweep rate may be adjusted to obtain the desired result.

MANUAL GATE/TRIGGER SWITCH

The Manual Pushbutton switch located on the front panel is used in conjunction with the Manual Gate/Trigger switch to provide a bounce-free switch for manually gating and triggering the Main Generator. Q520C and D are one-half of a Quadruple 2 Input Positive Nand Gate. Normally S520, the Manual Pushbutton, keeps one input of the Nand Gate, pin 9, at "0" and pins 8 and 12 at "1". Pin 13 is connected to +5V or a "1" through R521. With both inputs of Q520D positive, the output (pin 11) will remain at "0". The output of this Positive Nand Gate is connected through R508 to the Trigger Level Comparator. When S520, the Manual Pushbutton, is depressed, pin 13 of Q520D will be set to "0". This will cause the output (pin 11) to go to a "1" or positive state. This "1" is coupled through R508 to the Trigger Level Comparator Input. This "1" will remain until the Manual Pushbutton is released, allowing the output of Q520D to return to a "0".

MAIN GENERATOR LOCKOUT LOGIC GATE

Q520A and B is one-half of a Quadruple 2 Input Positive Nand Gate which provides the necessary logic function for the lockout amplifier Q525 and Q530 which operates as a switch. In the Run mode of operation, the trigger level comparator applies a "0" at the input of Q520A pin 1. As long as this "0" is present, the output of Q520A (pin 3) will remain positive ("1"). This positive signal will cause the lockout amplifier to remain in a "run" condition. In the Gate mode of operation, the trigger level comparator supplies a "1" to the logic input Q520A pin 1. The output will remain a "1" or in a "run" condition until a negative pulse ("0") is applied at Q520B pin 5 from the square wave. This negative pulse causes Q520B pin 6 to go to a "1" state which is connected to Q520A pin 2. Q520A output will now switch to a "0" causing the generator to lock out.

LOCKOUT AMPLIFIER

The lockout amplifier is a differential amplifier used as a Bi-polar switch. The output of Q525 provides ±1.8V to D525. D525 is forward biased in the Run mode of operation by Q525 collector (-1.8V) disabling the lockout current source. During lockout, Q525 is "off", reverse biasing D525 enabling the lockout current source.

3.2.5 SINE SHAPER AND AMPLIFIER CIRCUITS (Figure 6.2.5)

SINE CONVERTER

The Sine Converter converts the triangle to a sine by means of a bi-polar diode shaping network. The triangle is connected at TP602. R602 and R603 form a voltage divider to correctly match the triangle amplitude to the converter network. As the triangle rises positive, each diode gate will turn on in succession, causing the output of the network to form a sine wave at the junction of the three voltage dividers. The diode gates will turn on and off in sequence following the triangle. Sine A, B, C and D potentiometers. Adjust the current thru each bridge for minimum distortion.

SINE AMPLIFIER

This sine wave is amplified by differential amplifier Q600A and B. Q600C is a constant current source for the input differential stage. Sine D.C. Adj (R625) compensates for offset in the input pair, establishing a 0V reference at the Sine Output. A second differential stage is driven by Q600A and B. The output across R636 is connected to the Output Buffer (Q645 and Q650) through an emitter follower (Q635). The output (TP645) is connected through feedback resistors R626 and Sine Amplifier adjustment R627 to the inverting input. The sine wave is connected to S700 and S750 Amp 1 and Amp 2 Function switch.

± SINE

R646, R647 forms a voltage divider to decrease the sine amplitude. R649 and R648 (± Sine D.C.) provides offset current to establish a negative reference for the ± Sine. C646 (± Sine Comp.) provides high frequency compensation for the ± Sine. The ± Sine output (TP646) is connected to Amp 1 and Amp 2 through S700 and S750, the Amp 1 and Amp2 Function switches.

3.2.6 ATTENUATOR AND AMPLIFIER CIRCUITS (Figure 6.2.6)

INPUT BUFFERS

The Input Buffers Q700, Q705, Q750 and Q755 prevent loading from the low input impedance of the power amplifiers Amp 1 and Amp 2.

AMP 1

S700 connects the various waveforms to the inverting input. Q710A and B are the input differential amplifier. Q700C is a constant current source for Q700A and B. The D.C. BAL (R723) compensates for offset of the input pair and the Input Buffer. The D.C. Offset switch on the front panel supplies offset current to the non-inverting input for adjusting the D.C. reference at the output. Q725 and Q730 are a second differential stage driven by Q700A and B. The signal at Q730 is connected to the output through the output buffer, Q735 and Q740. R727 is selected to adjust the quiescent current in the output buffer to approximately 10ma. Gain is fixed by feedback resistors R731 and R704. Q745 is a current source for Q730 to improve slewing rate.

3.2.6 ATTENUATOR AND AMPLIFIER CIRCUITS (Continued)

AMP 2

Amp 2 is exactly the same amplifier connected as a non-inverting amplifier.

OUTPUT ATTENUATORS

The Output Attenuator provides six fixed levels of attenuation at 50Ω output impedance. The three attenuators are connected to add providing 10db, 20db, 30db, 40db, 50db and 60db of attenuation in 10db steps.

3.2.7 PULSE/BURST/SWEEP GENERATOR (Figure 6.2.7)

The P/B/S Generator provides a triangle waveform for pulsing, bursting and sweeping the Main Generator. The triangle is also available at each output amplifier. Amp 1 inverts the P/B/S triangle, providing the -PBS triangle. Amp 2 is non-inverting, providing the +PBS triangle.

INTEGRATOR

Q800 (CA3030) is an operational amplifier connected as an integrator. The output of the integrator is connected to a level detector which supplies a square wave to R801, the 100:1 timing variable. R802 is a bottoming resistor to set the 100:1 lower frequency limit. R803 provides adjustment of the timing current to the integrator for timing calibration. C801 thru C803 provide the 1MHz - 10KHz and 100Hz frequency ranges. R801 (100:1 variable) provides any frequency from 1Hz to 1MHz in conjunction with the three timing ranges. R807 (X1 Sym) compensates for input offset voltage in the operational amplifier. The P/B/S triangle is attenuated at TP815 and TP817 to obtain the proper output amp for Amp 1 and Amp 2 inputs. C807 provides high speed compensation for the level detector input.

LEVEL DETECTOR

Q820 is a high speed comparator. The triangle amplitude is set by R811 and R820. The output swing of Q820 is approximately ±2V.

TRI DC adjustment (R813) provides negative offset current to the level detector input offsetting the integrator output, to obtain a +4V triangle starting at 0V. Q825 is an emitter follower providing a -2V supply for the high speed comparator to obtain a bi-polar square wave. R828 (X10 Sym) adjusts the -2V reference voltage to obtain a 0V DC reference at Q820 output. Q830 is an emitter follower which provides a sync out pulse for the P/B/S Generator. D830 thru D833 clamp the output to approximately ±1.2V.

3.2.8 LOG AMPLIFIER

The log amplifier is used to obtain an exponential signal proportional to the VCF input voltage for use when sweeping over a 60db range (1000:1).

3.2.8 LOG AMPLIFIER (Continued)

The output of the summing amplifier normally drives the positive and negative current source drivers to obtain frequency control of the generator.

In the linear mode of operation (normal), the frequency of the generator changes linearly with a linear drive signal to an exponential signal. The principal of operation of the log amplifier is that the collector current of a transistor is logarithmetically related to the base emitter voltage by $I_c = A_{exp}(mV_b)$. The output of the summing amplifier is connected to the log amp input in the log mode. Q975 (log amp) has four separate 30db inputs for use over 120db range. Each stage is capable of approximately 30db. To obtain linearity over a 60db range, three of the four inputs are utilized and the fourth is grounded.

A_1 input will provide approximately 30db of useful range. To obtain an exponential curve over a 60db range, B_1 input is increased 30db by Amp_1. Q970 and A_2 input is attenuated 30db by the 15K resistor R975 and the 500Ω input. A_1 A_2 B_1 B_2 inputs will saturate at approximately 3V. Amp_1 and differential amp Q960 must be supply limited to keep the log amp input from saturating and becoming reverse biased internally. The three input stages will add, providing an exponential curve from approximately 2mv to > 2.5V. Q960 is a differential amplifier in the feedback loop of the log amp. This produces an inverted log function or an exponential curve.

R962 establishes the ORIGIN or zero input output voltage. R960, 965, 964 and 977 set the closed loop gain at approximately 1/10.

Q980 is an operational amp used to invert the signal and provide the necessary current for the current source drivers. The log timing pot R967 adjusts the gain of the inverter, thus the frequency.

V:f output Q985 is also an operational amplifier used to invert the negative signal to provide a low impedance voltage which is proportional to output frequency. This output can be used to drive an XY recorder or frequency meter.

The ±6V supply is provided by two zener diodes and the ±4V supplies are provided by two emitter followers Q950 and Q955.

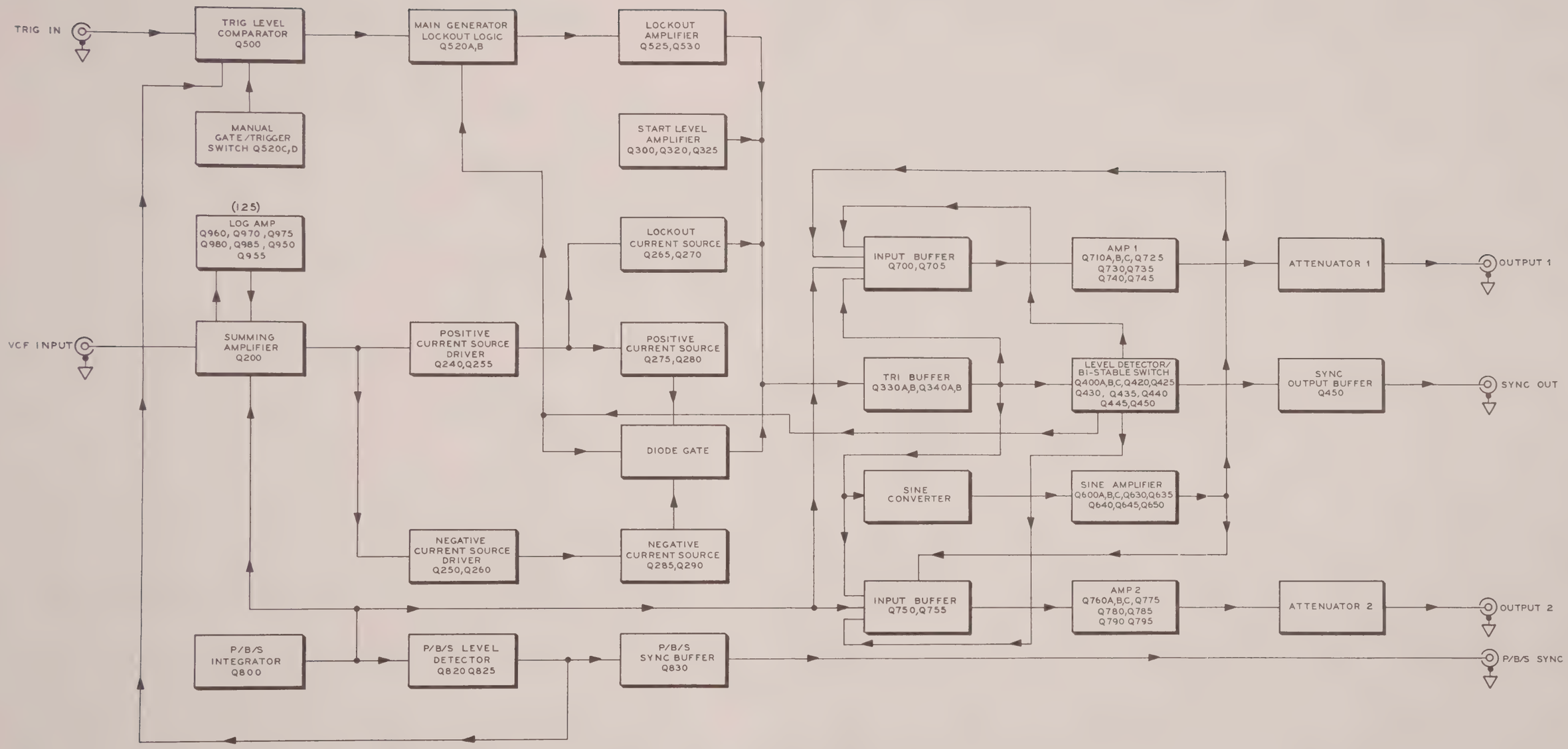


FIGURE 3.1.1
BLOCK DIAGRAM MODEL 124-125
2-15-71

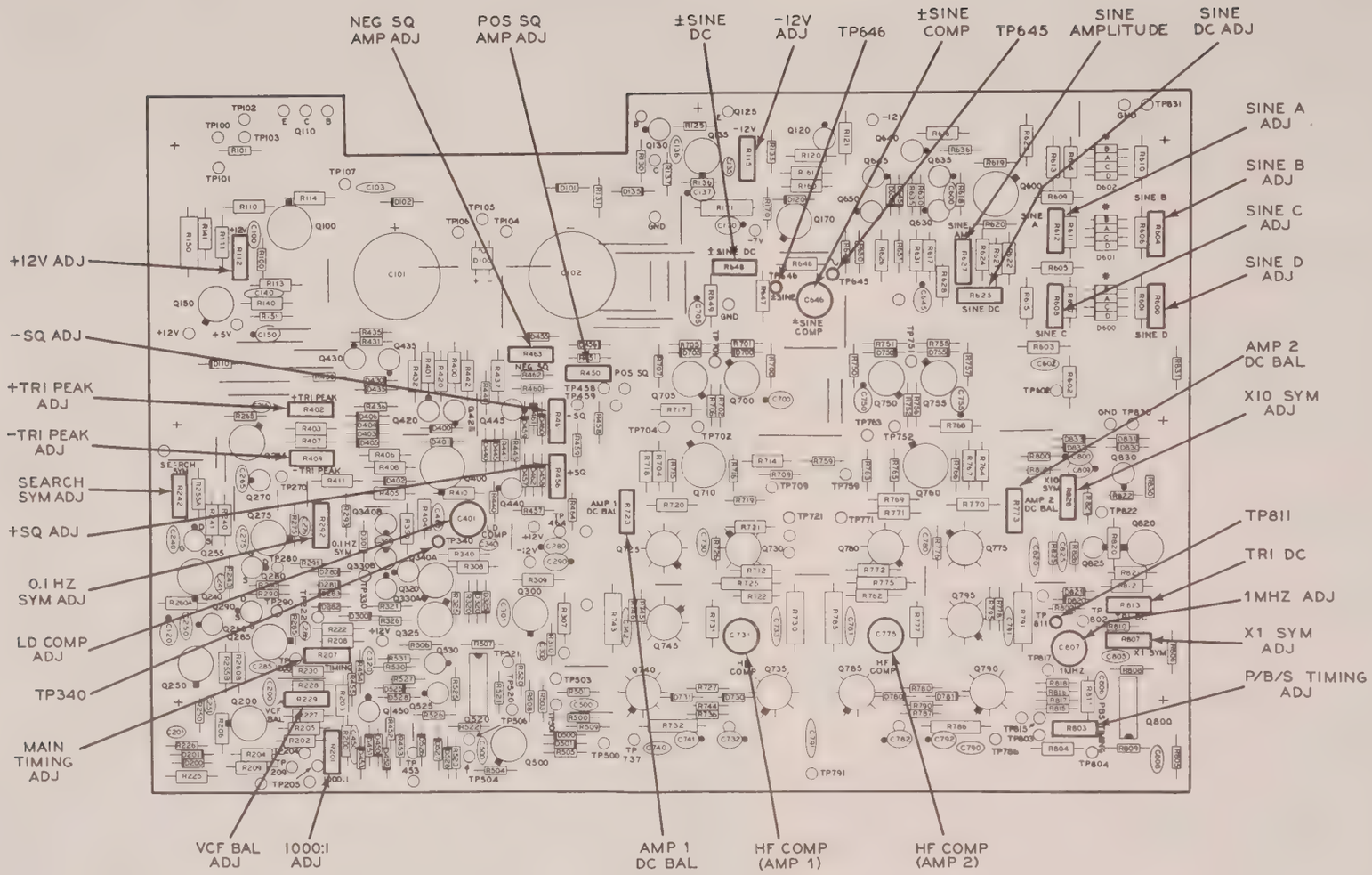


FIGURE 4.3.1
ADJUSTMENT LOCATION DETAIL MODEL 124

4.1.0 EQUIPMENT REQUIRED

The following test equipment or suitable equivalents of known accuracy are required for complete calibration.

Oscilloscope - D.C. to 50MHz. Differential plug-in with 10mv resolution
Distortion Analyzer
Variable Transformer
Variable Regulated Power Supply - 1mv resolution
Frequency Counter/Time Interval Counter
Differential Voltmeter - 0.01% accuracy

4.2.0 INITIAL CONTROL SETTINGS

POWER SWITCH	ON
RANGE	1K
MULTIPLIER	1.0
MODE	RUN
AMP 1, AMP 2	~
AMPLITUDE (Amp 1, Amp 2)	MAX
ATTENUATOR (Amp 1, Amp 2)	OFF
D.C. OFFSET (Amp 1, Amp 2)	OFF
P/B/S	10KHz
100:1 VARIABLE	CAL

4.3.0 CALIBRATION PROCEDURE (Figure 4.3.1 Foldout from last page, Section 4)

4.3.1 MAIN GENERATOR

+12V Adjust - Connect voltmeter from +12V to ground. Adjust +12V Adj for +12V ±5mv.

-12V Adjust - Connect voltmeter from -12V to ground. Adjust -12V Adj for -12V ±5mv.

VCF Balance Adjust, Set Multiplier .10 - Connect frequency counter to Sync Out jack. Adjust VCF balance until there is no frequency shift on frequency counter when VCF input is grounded.

± Triangle Peak Adjust - Using differential plug-in, adjust +Tri Peak and -Tri Peak to obtain ±1.25V peak ±10mv at TP340.

Main Timing Adjust, Set Multiplier 1.0 - Adjust Main Timing to obtain 1KHz ± .5% at Sync Output jack as observed on frequency counter.

1000:1 Adjust - Set Range to 100K, Multiplier to S .0. Monitor main output with oscilloscope and adjust 1000:1 Adj to obtain 100Hz triangle as indicated on frequency counter.

Search Symmetry Adjust - Set Range to 100K, Multiplier to S .0. Monitor main output with oscilloscope and adjust Search Symmetry to obtain symmetrical waveform.

4.3.1 MAIN GENERATOR (Continued)

0.1Hz Symmetry Adjust - Set Range to 1, Multiplier to .10. Connect time interval counter to the Sync Output jack and adjust 0.1Hz Sym for correct symmetry ±.5%.

Repeat 1000:1 Adjust, Search Symmetry and 0.1Hz Sym adjustments.

Level Detector Compensation - Monitor TP340 with oscilloscope. Adjust L.D. Comp. (C401) for 0db amplitude change from 100KHz to 5MHz.

5MHz Timing Adjust - Set Range to 5M, Multiplier to 1.0. Connect frequency counter to the Sync Output jack. Adjust 5MHz trimmer mounted on Range switch to obtain 5MHz ±1% on frequency counter.

± Square Amplitude Adjust - Set Amp 1, Amp 2 to Square. Set Range to 1K. Using differential plug-in, adjust +Square Amp and -Square Amp to obtain ±1.25V peak ±10mv square wave at TP459.

Positive Square Amplitude Adjust - Set Amp 1 Negative Square and Amp 2 Positive Square. Adjust Positive Square Amp to obtain +1.25V peak at TP458.

Negative Square Amplitude Adjust - Set Amp 1 Positive Square and Amp 2 Negative Square. Adjust Negative Square Amp to obtain -1.25V peak at TP464.

Amp 1 and Amp 2 Offset Adjust - Set Range to 1K, Multiplier to 1.0, Amp 1 and Amp 2 Amplitude to Minimum (full CCW). Monitor Amp 1, Amp 2 output with oscilloscope and adjust Amp 1 and Amp 2 D.C. Bal to obtain 0V D.C. reference at output.

Amp 1 and Amp 2 H.F. Comp. Adjust - Set Range to 1M, Multiplier to 1.0, Function to Square, Amplitude to Max. Terminate the Main output into 50Ω and monitor with oscilloscope. Adjust H.F. Comp to obtain optimum square wave with minimum overshoot.

Sine A, B, C, D Adjust - Set Range to 10K, Multiplier to 1.0, Amp 1 and Amp 2 to Sine. Connect distortion analyzer to Amp 1, Amp 2 Output jack. Adjust Sine A, B, C and D to obtain minimum sine distortion, typically less than 0.25%.

Sine Amplitude, Sine D.C. Adjust - Connect differential plug-in to TP645. Adjust Sine Amp and Sine D.C. to obtain ±1.25V peak ±10mv.

Repeat previous two steps due to interaction.

± Sine D.C. - Set Amp 1 to + Sine; monitor TP646 with oscilloscope. Adjust ± Sine D.C. to obtain 0V reference ±10mv at peak of sine.

± Sine Comp. - Monitor Amp 1 output with oscilloscope terminated into 50Ω. Adjust ± Sine Comp. for 0V reference on 5mHz frequency range.

4.3.2 PULSE/BURST/SWEEP GENERATOR

Set:

P/B/S	10KHz
100:1 Var	CAL

X10 Sym - Connect time interval counter to P/B/S Sync jack on rear panel. Adjust X10 Sym to obtain correct symmetry.

X1 Sym - Set 100:1 Variable Maximum CCW

Adjust X1 Sym to obtain correct symmetry as indicated on time interval counter. Repeat X10 Sym and X1 Sym adjustments if necessary.

Tri D.C. - Set 100:1 Variable to CAL position.

Monitor TP811 with oscilloscope and adjust Tri D.C. to obtain 0V reference at peak of triangle.

P/B/S Timing - Set:

P/B/S	10K
100:1 Var	CAL

Adjust P/B/S timing to obtain 10KHz ±2%

1MHz Trimmer - Set:

P/B/S	1MHz
100:1 Var	CAL

Adjust 1MHz trimmer to obtain 1MHz ±2%

5.3.3

Set:

RANGE	100KHz
MULT	1.0
MAIN MODE	RUN
LIN/LOG SW	LIN

AMP 1 BAL

Adjust Amp 1 BAL for 0mv offset between Pins 2 and 3 of Q970.

AMP 2 BAL

Adjust Amp 2 BAL for 0mv offset between Pins 2 and 3 of Q960.

AMP 3 BAL

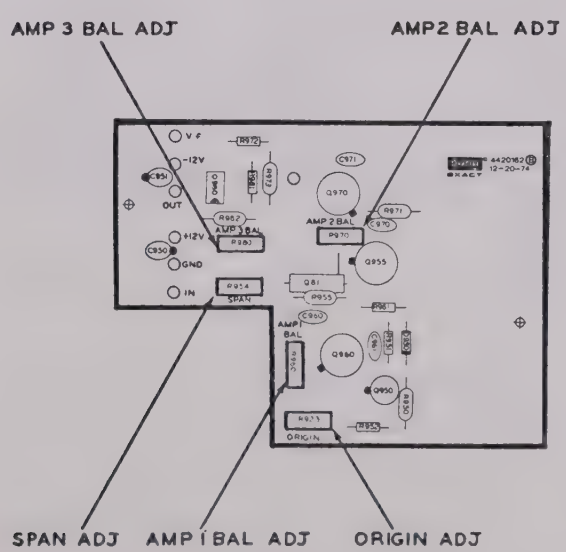
Adjust Amp 3 BAL for 0mv offset between Pins 2 and 3 of Q980.

ORIGIN

Set Multiplier to S.O with an output frequency of 100 Hz. Switch Lin/Log to Log and adjust ORIGIN for 100 Hz output.

SPAN

Set Multiplier to S.X and adjust SPAN to obtain the same frequency in Log and Lin modes.



CHECK LOG LINEARITY

1. Range 100 KHz
   Mult S.O
   Main Mode Run
   Lin/Log SW Log

   Monitor frequency on counter with 0V ± 1mv connected to the VCF input and adjust search vernier to obtain 100 Hz ± 2Hz.

2. Apply positive voltage at VCF input until frequency increases to 100 KHz ± 500 Hz and record input voltage.

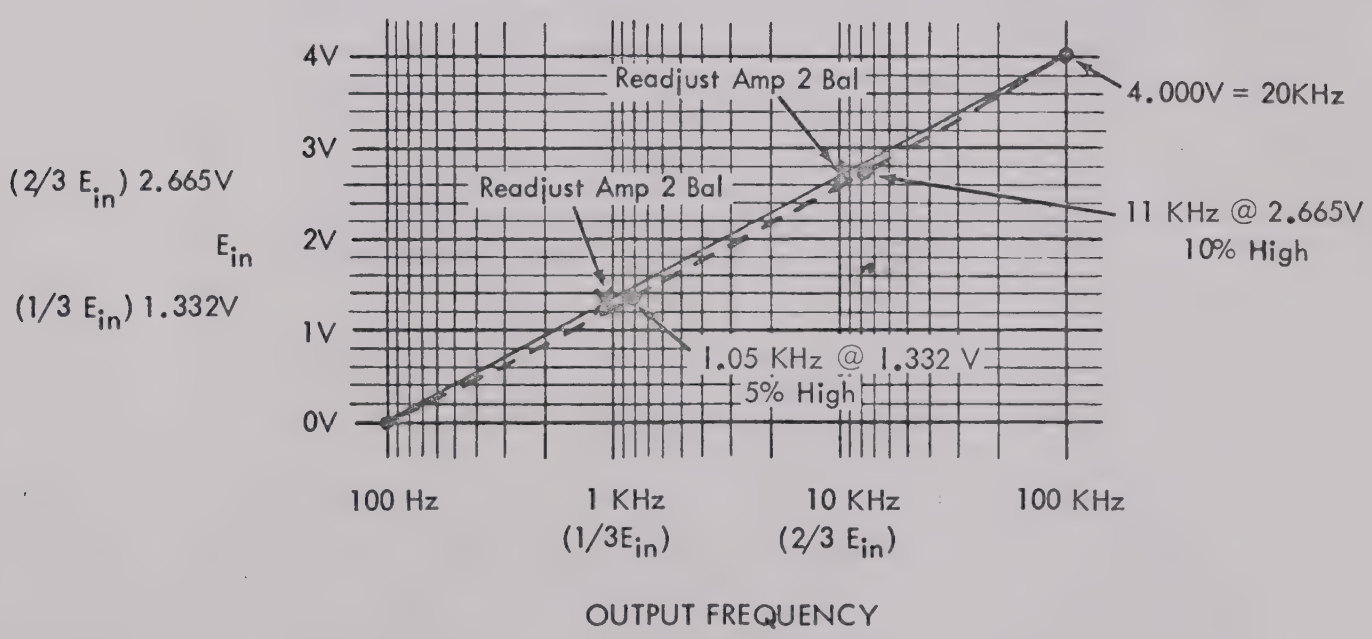
3. Multiply input voltage by 1/3 and 2/3.

4. Apply $2/3E_{in\ max}$ at VCF input and observe 10 KHz ± 500 Hz.

5. Apply $1/3E_{in\ max}$ at VCF input and observe 1 KHz ± 50Hz.

6. Adjust Amp 2 BAL to correct linearity if required at approximately 10%/mv.

EXAMPLE:



Step 1:

Range	100K
Mult	S.O
Main Mode	Run
Lin/Log SW	Log

Monitor output frequency on counter with 0V ± 1mv connected to VCF input and adjust search vernier to obtain 100 Hz ± 2 Hz.

Step 2:

VCF Voltage	Output Frequency
4.00V	100 KHz

Step 3: 4.00 X 2/3 = 2.665
4.00 X 1/3 = 1.332

Step 4: E_{in} = 2.665 F_{out} = 11.0 KHz (should be 10 KHz)

Step 5: E_{in} = 1.332 F_{out} = 1.05 KHz (should be 1 KHz)

Step 6: In the above example, both frequency readings are high indicating a slight bow in the curve. When both readings are high, as in the above example or both low; the "bow" may be decreased by adjusting Amp 2 BAL as indicated in #6 of the Log Linearity check.

In this case, the frequency was 10% high at 10 KHz and 5% high at 1 KHz. By readjusting Amp 2 BAL 1mv more negative than its original setting, it will decrease the frequency from 11 KHz (10% high) to approximately 10KHz, and from 1.05 KHz (5% high) to approximately .95 KHz (-5%) as indicated on the graph.

By carefully adjusting Amp 2 BAL, the curve may be adjusted to its optimum linearity (when the error at 10 KHz is equal and opposite to the error at 1 KHz).

SECTION 5

PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Sprgs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidoil Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Prod. Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Eng. Labs, Inc.	Burlington, Wis
00853	Sangamo Electric Co., Ordill Div. (Caps)	Marion, Illinois
00866	Goe Engineering Co.	Los Angeles, Calif
00891	Carl E. Holmes Corp.	Los Angeles, Calif
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Prod. Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Inc.
01589	Pacific Relays, Inc.	Van Nuys, Calif
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif
02114	Ferrocube Corp/Amer.	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
0277	Vocaline Company of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q, Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co. Electronics Div.	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
047 3	Motorola/Semicon. Prod.	Phoenix, Ari:ona
04732	Filtron Co/Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Illinois
04777	Automatic Elect. Sales Corp.	Northlake, Illinois
04796	Sequoia Wire/Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon. Dept.	Youngwood, Pa.
05347	Uttronix, Inc.	San Mateo, Calif.
05593	Illumitronic Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co.	Roslyn Heights, L.I., N.Y.
05729	Metropolitan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical	Rochester, N.Y.
06402	E.T.A. Products/Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Inst.Co.	Penacook, N.H.
06751	U.S. Semcor Div. of Nuclear Corp/Amer.	Phoenix, Ariz.
06812	Torrington Mfg Co, West Div.	Van Nuys, Calif.
07008	Kelvin Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronics Comp. Dept.	Bradford, Pa.
07126	Digitron Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Bircher Corp.	Los Angeles, Calif.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07964	Shockley Semi-Conductor Labs	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert, Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario
08717	Sloan Company	Burbank, Calif.
08718	Cannon Elect Co., Phoenix Div.	Phoenix, Ariz.
08792	CBS Elect. Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Illinois
09569	Mallory Battery Co/Canada Ltd.	Toronto, Ontario, Canada
09664	The Bristol Company	Waterbury, Conn.
10214	Gen. Trans. Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10597	Exact Electronics, Inc.	Hillsboro, Oreg.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Tel. of Calif., Inc.	S. Pasadena, Calif.
11312	Microwave Elect. Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	Gen'l Inst/Semiconductor Div	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.

Code No.	Manufacturer	Address
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell Dubilier El. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	De Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio, Division of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics, Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
1970-	Electro Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Illinois
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E. Lamp Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
28462	Grobet File Co/America, Inc.	Carlstadt, N.J.
28992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	GE Receiving Tube Dept.	Owensboro, Ky.
34434	Lectrohm, Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesburn, Ontario, Ca.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod.	Akron, Ohio
40920	Miniature Precision Bearings	Keene, N.H.
42190	Muter Co.	Chicago, Illinois
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer/Inst.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52099	Rowan Controller Co.	Baltimore, Md.
53743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Illinois
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson and Co., Inc.	S. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	N. Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas and Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	West Inst./Div. Daystrom	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago, Illinois
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co, Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Centralab, Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71753	A. O. Smith Corp. Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Illinois
71984	Daw Carning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co, Inc.	Willimantic, Conn.
71707	Cato Coil, Co., Inc.	Providence, R.I.
72354	John E Fast and Company	Chicago, Illinois
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp. Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Illinois
72825	Hugh H. Eby, Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Illinois
72965	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H. M. Harper Co.	Chicago, Illinois
73138	Helipot, Div. Beckman Instruments, Inc.	Fullerton, Calif.

Code No.	Manufacturer	Address
73293	Hughes Products Div. of Hughes Aircrft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. No. American Philips Co., Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	S. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Illinois
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping and Tool	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signolite, Inc.	Neptune, N.J.
74455	J. H. Winns and Sons	Winchester, Mass.
7486	Industrial Condenser Corp.	Chicago, Illinois
74868	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75378	James Knights Co.	Sandwich, Illinois
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Illinois
75915	Littelfuse, Inc.	Des Plaines, Illinois
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp	Brooklyn, N.Y.
7648/	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Illinois
77068	Bendix Pacific Div. of Bendix Corp.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostron Instrument and Electronic Co.	S. Pasadena, Calif.
77250	Phoell Manufacturing Co.	Chicago, Illinois
77252	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine/Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn, Inc.	Pitman, N.J.
78452	Thompson-Bremer and Co.	Chicago, Illinois
78471	Tilley Manufacturing Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78590	Transformer Engineers	Pasadena, Calif.
78947	Uginite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Illinois
79727	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco, Div. of Sessions Clock Company	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80 30	Times Facsimile Corp.	New York, N.Y.
80 3-	Electronic Industries Assoc. Any brand tube meeting EIA standards.	Washington D.C.
80207	Unimax Switch, Div. of W L Maxson Corp.	Waltingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Illinois
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro, Div. Robershaw Fulton Controls Co.	Columbus, Ohio Columbus, Ohio
80486	All Star Products, Inc.	Defiance, Ohio
80509	Avary Adhesive Label Corp.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Graybill Co.	LaGrange, Illinois
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co, Inc.	Norwalk, Conn.
81349	Military Specifications	. . .
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div. Industrial Tube Oper.	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Illinois
82 42	Jeffers Electronics, Div. of Speer Carbon Co.	DuBois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Electronic Tube Div.	Emporium, Pa.
82376	Astron Company	E. Newark, N.J.
82389	Switchcraft, Inc.	Orange, Illinois
82647	Metals and Controls, Inc., Div. Texas Instruments, Spencer Products	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wisc.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, California
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing Pyramid Electric Co.	Peterborough, N.H.
83125	Industrial Tube Corp.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp/Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Illinois
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Illinois
83501	Gavitt Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.

Code No.	Manufacturer	Address
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Co.	Boonton, N.J.
85474	R.M. Bracarontis and Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Illinois
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansing Div.)	Lansing, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco
87864	Van Waters and Rogers, Inc.	Seattle, Wash.
87930	Icwer Mfg. Co.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Illinois
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89462	Waldes Kohinoor, Inc.	Cambridge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89665	United Transformer Co.	Chicago, Illinois
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Illinois
91506	August Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Neb.
91662	Elco Corp.	Philadelphia
91737	Gremar Mfg Co., Inc.	Wakefield. Mass.
91929	Minneapolis-Honeywe l Regulator Co., Micrswitch Div.	Freeport, Illinois
91961	Nehn-Bras. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod, Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith, Inc.	Port Mnnmouth, N.J.
93929	G.V. Controls	Livingston, N.J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Comp. Div., Rec. Tube Div.	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94148	Scientific Radio Products	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtis-Wright Corp., Electronics Div.	E. Paterson, N.J.
94222	Southco, Div. S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod., Div. Model Engineering and Mfg. Co.	Chicago, Illinois
94330	Wire Cloth Products, Inc.	Chicago, Illinois
94682	Worcester Pressed Alum. Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Illinois
95712	Doge Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co.	Chicago, Illinois
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner, Div. Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Illinois
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg.	Yonkers, N.Y.
97966	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gurdena, Calif
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	S. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Div, Controls Co. of America	El Segundo, Calif
99800	Delevan Electronics Corp.	E. Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Illinois
99957	Technology Instrument Corp. of California	Newbury Park, Calif.

PART	DESCRIPTION	EXACT NO	MFG
B100	PILOT LIGHT	1360845	18085
C100	CAPACITOR, 470PF MICA	2810539	853
C101	CAPACITOR, 2500MFD 35V	2900834	853
C102	CAPACITOR, 2500MFD 35V	2900834	853
C103	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C120	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C135	CAPACITOR, 5000 PF DISCAP	2830811	91418
C136	CAPACITOR, 220PF MICA	2810555	853
C140	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C150	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C170	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C200	CAPACITOR, 220PF MICA	2810555	853
C201	CAPACITOR, 5000 PF DISCAP	2830811	91418
C240	CAPACITOR, 220PF MICA	2810555	853
C241	CAPACITOR, 5000 PF DISCAP	2830811	91418
C250	CAPACITOR, 220PF MICA	2810555	853
C251	CAPACITOR, 5000 PF DISCAP	2830811	91418
C265	CAPACITOR, 220PF MICA	2810555	853
C266	CAPACITOR, 5000 PF DISCAP	2830811	91418
R265	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070152	1121
C275	CAPACITOR, 220PF MICA	2810555	853
C276	CAPACITOR, 5000 PF DISCAP	2830811	91418
C280	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C285	CAPACITOR, 220PF MICA	2810555	853
C286	CAPACITOR, 5000 PF DISCAP	2830811	91418
C290	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C301	CAPACITOR, 220PF MICA	2810555	853
C302	CAPACITOR, 5000 PF DISCAP	2830811	91418
C320	CAPACITOR, 22PF MICA	2810530	853
C330	CAPACITOR, 8-50PF TRIM	2810822	72982
C331	CAPACITOR, 150PF MICA	2810557	853
C332	CAPACITOR, TIMING SET	2950804	18997
C334	RESISTOR, SELECTED VALUE		
C340	CAPACITOR, 1000 PF DISCAP	2830808	91418
C345	CAPACITOR, 1000 PF DISCAP	2830808	91418
C400	CAPACITOR, 47PF MICA	2810532	853
C401	CAPACITOR, 8-50PF TRIM	2810822	72982
C450	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C451	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C500	CAPACITOR, 68PF MICA	2810523	853
C501	CAPACITOR, 150PF MICA	2810557	853
C502	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C600	CAPACITOR, 100PF MICA	2810537	853
C602	CAPACITOR, 120PF MICA	2810534	853
C645	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C646	CAPACITOR, 8-50PF TRIM	2810822	72982
C700	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C705	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C730	CAPACITOR, 220PF MICA	2810555	853
C731	CAPACITOR, 3-12PF TRIM	2810836	72982
C732	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C733	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C740	CAPACITOR, 220PF MICA	2810555	853
C741	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C742	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C742	CAPACITOR, 68PF MICA	2810523	853
C750	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C755	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C775	CAPACITOR, 3-12PF TRIM	2810836	72982
C780	CAPACITOR, 220PF MICA	2810555	853
C781	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C782	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C790	CAPACITOR, 220PF MICA	2810555	853
C791	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C791	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C792	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C799	CAPACITOR, 68PF MICA	2810523	853
C800	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C801	CAPACITOR, 100PF MICA	2810537	853
C802	CAPACITOR, 0,01MFD 600V	2900819	37942
C803	CAPACITOR, 1MFD 100V	2900822	84411
C805	CAPACITOR, 39PF MICA	2810531	853
C806	CAPACITOR, 5PF MICA	2810501	853
C807	CAPACITOR, 3-12PF TRIM	2810836	72982
C808	CAPACITOR, 39PF MICA	2810531	853
C809	CAPACITOR, 6,8 MFD 35 VOLT	2900843	100002
C826	CAPACITOR, 0,05 UF DISCAP	2830818	91418
C825	CAPACITOR, 0,05 UF DISCAP	2830818	91418
D100	RECTIFIER BRIDGE, MDA920A	1520920	4713
D101	DIODE, 1N4001	1524001	1295
D102	DIODE, 1N4001	1524001	1295
D110	DIODE, 1N4001	1524001	1295
D120	DIODE, 1N4001	1524001	1295
D135	DIODE, 1N756	1520756	1295
D200	DIODE, 1N914	1520914	7910
D201	DIODE, 1N914	1520914	7910
D280	DIODE, FD777	1520777	1295
D281	DIODE, FD777	1520777	1295
D282	DIODE, FD777	1520777	1295
D283	DIODE, FD777	1520777	1295
D300	DIODE, FD777	1520777	1295
D301	DIODE, FD777	1520777	1295
D320	DIODE, 1N914	1520914	7910
D325	DIODE, 1N914	1520914	7910
D400	DIODE, 1N914	1520914	7910
D401	DIODE, 1N914	1520914	7910
D402	DIODE, 1N914	1520914	7910
D403	DIODE, FD777	1520777	1295
D404	DIODE, FD777	1520777	1295
D406	DIODE, FD777	1520777	1295
D430	DIODE, 1N914	1520914	7910
D435	DIODE, 1N914	1520914	7910
D440	DIODE, 1N914	1520914	7910
D445	DIODE, 1N914	1520914	7910
D450	CAPACITOR, 0,05 UF DISCAP	2830818	91418
D450	DIODE, 1N914	1520914	7910
D451	DIODE, 1N914	1520914	7910
D526	DIODE, 1N914	1520914	7910
D452	DIODE, 1N914	1520914	7910
D453	DIODE, 1N914	1520914	7910
D455	DIODE, FD777	1520777	1295
D456	DIODE, FD777	1520777	1295
D457	DIODE, FD777	1520777	1295
D458	DIODE, FD777	1520777	1295
D459	DIODE, FD777	1520777	1295
D460	DIODE, FD777	1520777	1295
D461	DIODE, FD777	1520777	1295
D462	DIODE, FD777	1520777	1295
D500	DIODE, 1N914	1520914	7910
D501	DIODE, 1N914	1520914	7910
D525	DIODE, FD777	1520777	1295
D527	DIODE, 1N914	1520914	7910
D528	DIODE, 1N914	1520914	7910
D600	DIODES, MATCHED SET FD777	1530777	18997
D601	DIODES, MATCHED SET FD777	1530777	18997
D602	DIODES, MATCHED SET FD777	1530777	18997
D645	DIODE, 1N914	1520914	7910
D650	DIODE, 1N914	1520914	7910
D700	DIODE, 1N914	1520914	7910
D705	DIODE, 1N914	1520914	7910
D730	DIODE, 1N914	1520914	7910
D731	DIODE, 1N914	1520914	7910
D750	DIODE, 1N914	1520914	7910
D755	DIODE, 1N914	1520914	7910
D780	DIODE, 1N914	1520914	7910
D781	DIODE, 1N914	1520914	7910
D820	DIODE, 1N914	1520914	7910
D821	DIODE, 1N914	1520914	7910
D830	DIODE, 1N914	1520914	7910
D831	DIODE, 1N914	1520914	7910
D833	DIODE, 1N914	1520914	7910
F100	FUSE, 3AG 1/2 AMP	1590815	71400
J100	BINDING POST, BLACK	3550536	18997
J101	BINDING POST, WHITE	3550535	18997
J200	TO		
J830	CONNECTOR, BNC	1310847	91836
Q100	INTEGRATED CIRCUIT, UA723	1580812	7263
Q110	TRANSISTOR, 2N4910	1564910	4713
Q120	TRANSISTOR, 2N3643	1563643	4713
Q125	TRANSISTOR, 2N4898	1564898	4713
Q130	TRANSISTOR, 2N4121	1564121	7263
Q135	OPERATIONAL AMPLIFIER, UA709	1580816	7263
Q150	TRANSISTOR, 2N2219	1562219	1295
Q170	TRANSISTOR, 2N2905	1562905	1295
Q200	OPERATIONAL AMPLIFIER, UA709	1580816	7263
Q240	OPERATIONAL AMPLIFIER, UA709	1580816	7263
Q245	TRANSISTOR, MPS3640	1563640	4713
Q250	OPERATIONAL AMPLIFIER, UA709	1580816	7263
Q255	TRANSISTOR, 2N5485	1565485	4713
Q260	TRANSISTOR, 2N4250	1564250	7263
Q265	OPERATIONAL AMPLIFIER, UA709	1580816	7263
Q270	TRANSISTOR, 2N4250	1564250	7263
Q275	OPERATIONAL AMPLIFIER, UA709	1580816	7263
Q280	TRANSISTOR, 2N5462	1565462	4713
Q285	OPERATIONAL AMPLIFIER, UA709	1580816	7263
Q290	TRANSISTOR, 2N5485	1565485	4713
Q300	OPERATIONAL AMPLIFIER, UA709	1580816	7263
Q320	TRANSISTOR, 2N2219	1562219	1295
Q325	TRANSISTOR, 2N2905	1562905	1295
Q330	TRANSISTORS, MATCHED 2N5485	1575485	18997
Q340	TRANSISTORS, MATCHED PAIR MPS3646	1570808	18997
Q400	INTEGRATED CIRCUIT, CA3018	1580829	2735
Q420	TRANSISTOR, MPS3640	1563640	4713
Q430	TRANSISTOR, MPS3646	1563646	4713
Q435	TRANSISTOR, MPS3640	1563640	4713
Q440	TRANSISTOR, MPS3646	1563646	4713
Q445	TRANSISTOR, MPS3640	1563640	4713
Q450	TRANSISTOR, 2N4121	1564121	7263
Q500	INTEGRATED CIRCUIT, UA710C	1580820	7263
Q520	INTEGRATED CIRCUIT, SN7400N	1580811	1295
Q525	TRANSISTOR, MPS3640	1563640	4713
Q530	TRANSISTOR, MPS3640	1563640	4713
Q600	INTEGRATED CIRCUIT, CA3018	1580829	2735
Q630	TRANSISTOR, MPS3640	1563640	4713
Q635	TRANSISTOR, MPS3640	1563640	4713
Q640	TRANSISTOR, MPS3646	1563646	4713
Q645	TRANSISTOR, MPS3646	1563646	4713
Q650	TRANSISTOR, MPS3640	1563640	4713
Q700	TRANSISTOR, 2N2219	1562219	1295
Q705	TRANSISTOR, 2N2905	1562905	1295
Q710	INTEGRATED CIRCUIT, CA3018	1580829	2735
Q725	TRANSISTOR, 2N2905	1562905	1295
Q730	TRANSISTOR, 2N2905	1562905	1295
Q735	TRANSISTOR, 2N2219	1562219	1295
Q740	TRANSISTOR, 2N2905	1562905	1295
Q745	TRANSISTOR, 2N2219	1562219	1295
Q750	TRANSISTOR, 2N2219	1562219	1295
Q755	TRANSISTOR, 2N2905	1562905	1295
Q760	INTEGRATED CIRCUIT, CA3018	1580829	2735
Q775	TRANSISTOR, 2N2905	1562905	1295
Q780	TRANSISTOR, 2N2905	1562905	1295
Q785	TRANSISTOR, 2N2219	1562219	1295
Q790	TRANSISTOR, 2N2905	1562905	1295
Q795	TRANSISTOR, 2N2219	1562219	1295
Q800	OPERATIONAL AMPLIFIER, CA3030A	1580808	2735
Q820	INTEGRATED CIRCUIT, UA710C	1580820	7263
Q825	TRANSISTOR, 2N4121	1564121	7263
Q830	TRANSISTOR, 2N4121	1564121	7263
R100	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122	1121
R101	RESISTOR, 68K OHM 1/4W 5% CARBON	3070683	1121
R110	RESISTOR, 1,8 OHM 1/2W 5% CARBON	3010018	1121
R111	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R112	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R113	RESISTOR, 3240 OHM 1/4W 1% METAL FILM	3133241	7115
R114	RESISTOR, 9760 OHM 1/4W 1% METAL FILM	3139761	7115
R135	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121

PART	DESCRIPTION	EXACT NO	MFG
R115	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R120	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R121	RESISTOR, 1.8 OHM 1/2W 5% CARBON	3010018	1121
R125	RESISTOR, 68 OHM 1/4W 5% CARBON	3070688	1121
R130	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070182	1121
R131	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332	1121
R136	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R137	RESISTOR, 51 OHM 1/4W 5% CARBON	3070518	1121
R141	RESISTOR, 1100 OHM 1/4W 1% METAL FILM	3131181	7115
R150	RESISTOR, 150 OHM 1W 5% CARBON	3030151	1121
R151	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R226	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R160	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R161	RESISTOR, 1820 OHM 1/4W 1% METAL FILM	3131821	7115
R170	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R171	RESISTOR, 470 OHM 1W 5% CARBON	3030471	1121
R200	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R201	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R202	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R203	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R204	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R205	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R206	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R266	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R207	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R208	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501	7115
R228	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R210	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
R211	RESISTOR, SELECTED VALUE		
R212	TO		
R222	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R224	RESISTOR, 18R OHM 1/8W 1% METAL FILM	3181808	7115
R225	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R227	RESISTOR, 962K OHM 1/4W 1% METAL FILM	3139623	7115
R228	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R229	POTENTIOMETER, 2K OHM PC TRIM	3110138	78488
R230	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R240	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R241	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R242	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R243	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R258	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R255	RESISTOR, 806 OHM MATCHED PAIR	3128868	10597
R260	RESISTOR, 806 OHM MATCHED PAIR	3128868	10597
R275	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R276	RESISTOR, 806 OHM MATCHED PAIR	3128868	10597
R280	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R285	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R290	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R291	RESISTOR, 10000K OHM 1/4W 5% CARBON	3070106	1121
R292	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R293	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R300	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020	7115
R301	RESISTOR, 4020 OHM 1/4W 1% METAL FILM	3134021	7115
R302	RESISTOR, 40200 OHM 1/4W 1% METAL FILM	3134022	7115
R304	RESISTOR, 8068 OHM MATCHED PAIR	3128861	10597
R305	RESISTOR, 80600 OHM MATCHED PAIR	3128862	10597
R306	SWITCH, ROTARY	2600331	10597
R307	RESISTOR, 84500 OHM 1/4W 1% METAL FILM	3134852	7115
R308	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R309	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R310	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R320	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R321	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R325	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R323	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R330	RESISTOR, SELECTED VALUE		
R331	RESISTOR, SELECTED VALUE		
R340	RESISTOR, 220 OHM 1/2W 5% CARBON	3010221	1121
R350	RESISTOR, 383 OHM 1/4W 1% METAL FILM	3133830	7115
R400	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R401	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R402	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R403	RESISTOR, 4930 OHM 1/4W 1% METAL FILM	3134931	7115
R404	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020	7115
R405	DIODE, FD777	1920777	1295
R406	RESISTOR, 392 OHM 1/4W 1% METAL FILM	3133920	7115
R407	RESISTOR, 274 OHM 1/4W 1% METAL FILM	3132748	7115
R408	RESISTOR, 4930 OHM 1/4W 1% METAL FILM	3134931	7115
R409	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R409	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R410	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R411	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R428	RESISTOR, 976 OHM 1/4W 1% METAL FILM	3139768	7115
R430	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R431	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R432	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134758	7115
R435	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R436	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R437	RESISTOR, 715 OHM 1/4W 1% METAL FILM	3137158	7115
R440	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R441	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R442	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134758	7115
R445	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R446	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R450	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R451	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122	1121
R452	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R453	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R454	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R455	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R456	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R457	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122	1121
R458	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331	1121
R459	RESISTOR, 200 OHM 1/4W 5% CARBON	3070201	1121
R460	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122	1121
R461	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R462	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122	1121

PART	DESCRIPTION	EXACT NO	MFG
R463	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R464	RESISTOR, 200 OHM 1/4W 5% CARBON	3070201	1121
R465	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R501	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R503	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R504	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333	1121
R505	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302	1121
R506	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332	1121
R507	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R508	RESISTOR, 100K OHM 1/4W 5% CARBON	3070104	1121
R509	RESISTOR, 330K OHM 1/4W 5% CARBON	3070334	1121
R520	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R521	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R522	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R523	RESISTOR, 820 OHM 1/4W 5% CARBON	3070821	1121
R525	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751	1121
R526	RESISTOR, 4300 OHM 1/4W 5% CARBON	3070432	1121
R527	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511	1121
R528	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751	1121
R530	RESISTOR, 4300 OHM 1/4W 5% CARBON	3070432	1121
R531	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R600	POTENTIOMETER, 2K OHM PC TRIM	3110138	78488
R601	RESISTOR, 7900 OHM 1/4W 1% METAL FILM	3137901	7115
R602	RESISTOR, 82,5 OHM 1/8W 1% METAL FILM	3138825	7115
R603	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R604	POTENTIOMETER, 2K OHM PC TRIM	3110138	78488
R605	RESISTOR, 309 OHM 1/4W 1% METAL FILM	3133090	7115
R606	RESISTOR, 9538 OHM 1/4W 1% METAL FILM	3139531	7115
R607	RESISTOR, 7900 OHM 1/4W 1% METAL FILM	3137901	7115
R608	POTENTIOMETER, 2K OHM PC TRIM	3110138	78488
R609	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R610	RESISTOR, 19100 OHM 1/4W 1% METAL FILM	3131912	7115
R611	RESISTOR, 9538 OHM 1/4W 1% METAL FILM	3139531	7115
R612	POTENTIOMETER, 2K OHM PC TRIM	3110138	78488
R613	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R614	RESISTOR, 19100 OHM 1/4W 1% METAL FILM	3131912	7115
R615	RESISTOR, 49,9 OHM 1/4W 1% METAL FILM	3138499	7115
R616	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R617	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R618	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121	1121
R619	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R620	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R621	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R622	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R623	RESISTOR, 681 OHM 1/4W 1% METAL FILM	3136810	7115
R624	RESISTOR, 33200 OHM 1/4W 1% METAL FILM	3133322	7115
R625	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R626	RESISTOR, 442 OHM 1/4W 1% METAL FILM	3134420	7115
R627	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R628	RESISTOR, 63,4 OHM 1/4W 1% METAL FILM	3130634	7115
R630	RESISTOR, 39 OHM 1/4W 5% CARBON	3070390	1121
R631	RESISTOR, 330 OHM 1/2W 5% CARBON	3010331	1121
R635	RESISTOR, 39 OHM 1/4W 5% CARBON	3070390	1121
R636	RESISTOR, 2480 OHM 1/4W 5% CARBON	3072482	1121
R645	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R646	RESISTOR, 619 OHM 1/4W 1% METAL FILM	3136190	7115
R647	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R648	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R649	RESISTOR, 4750 OHM 1/4W 1% METAL FILM	3134751	7115
R650	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R651	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302	1121
R700	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R701	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R702	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R745	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331	1121
R704	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R705	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R706	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R707	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R708	SWITCH, ROTARY	2600329	10597
R709	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R710	POTENTIOMETER, 10K OHM WITH SWITCH	3110333	71450
R712	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R714	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R715	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R716	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R717	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R718	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R719	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121	1121
R720	RESISTOR, 33200 OHM 1/4W 1% METAL FILM	3133322	7115
R721	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R722	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R723	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R725	RESISTOR, 301 OHM 1/2W 1% METAL FILM	3130310	7115
R726	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R727	RESISTOR, SELECTED VALUE		
R730	RESISTOR, 68 OHM 1W 5% CARBON	3030680	1121
R731	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R732	RESISTOR, 47,5 OHM 1/2W 1% METAL FILM	3100475	7115
R733	RESISTOR, 26,1 OHM 1/4W 1% METAL FILM	3130261	7115
R734	RESISTOR, 34,8 OHM 1/4W 1% METAL FILM	3130348	7115
R735	RESISTOR, 26,1 OHM 1/4W 1% METAL FILM	3130261	7115
R736	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R737	RESISTOR, 41,2 OHM 1/2W 1% METAL FILM	3100412	7115
R738	RESISTOR, 10,0 OHM 1/4W 1% METAL FILM	3130100	7115
R739	RESISTOR, 41,2 OHM 1/2W 1% METAL FILM	3100412	7115
R740	RESISTOR, 46,4 OHM 1/2W 1% METAL FILM	3100464	7115
R741	RESISTOR, 3,16 OHM 1/8W 1% DEP, CARBON	3193160	7115
R742	RESISTOR, 46,4 OHM 1/2W 1% METAL FILM	3100464	7115
R743	RESISTOR, 68 OHM 1W 5% CARBON	3030680	1121
R744	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R746	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301	1121
R750	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R751	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R752	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R755	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R756	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R757	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121

LOG AMPLIFIER

PART	DESCRIPTION	EXACT NO	MFG
R758	SWITCH, ROTARY	2600329	10597
R759	RESISTOR, 22 OHM 1/4W 5% CARBON	3070228	1121
R760	POTENTIOMETER, 10K OHM WITH SWITCH	3110333	71450
R762	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R763	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121	1121
R764	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R765	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R766	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R767	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R768	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R769	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R770	RESISTOR, 33200 OHM 1/4W 1% METAL FILM	3133322	7115
R771	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R772	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R773	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R775	RESISTOR, 301 OHM 1/2W 1% METAL FILM	3103010	7115
R776	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R777	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R778	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331	1121
R780	RESISTOR, SELECTED VALUE		
R785	RESISTOR, 68 OHM 1W 5% CARBON	3030685	1121
R786	RESISTOR, 47.5 OHM 1/2W 1% METAL FILM	3100475	7115
R787	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R788	RESISTOR, 20.1 OHM 1/4W 1% METAL FILM	3130201	7115
R789	RESISTOR, 34.8 OHM 1/4W 1% METAL FILM	3130348	7115
R790	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R791	RESISTOR, 68 OHM 1W 5% CARBON	3030680	1121
R792	RESISTOR, 20.1 OHM 1/4W 1% METAL FILM	3130201	7115
R793	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412	7115
R794	RESISTOR, 18.0 OHM 1/4W 1% METAL FILM	3130180	7115
R795	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301	1121
R796	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412	7115
R797	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3100464	7115
R798	RESISTOR, 3.16 OHM 1/8W 1% DEP. CARBON	3193160	7115
R799	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3100464	7115
R800	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R801	SWITCH, ROTARY	2600330	10597
R802	RESISTOR, 82 OHM 1/4W 5% CARBON	3070820	1121
R803	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R804	RESISTOR, 2370 OHM 1/4W 1% METAL FILM	3132371	7115
R805	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R806	RESISTOR, 100K OHM 1/4W 5% CARBON	3070105	1121
R807	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R808	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681	1121
R809	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R810	RESISTOR, 6800 OHM 1/4W 5% CARBON	3070682	1121
R811	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R812	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R813	POTENTIOMETER, 10K OHM TRIM	3110138	71450
R814	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R815	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R816	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162	1121
R817	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R818	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162	1121
R820	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R821	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R822	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R825	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R826	RESISTOR, 6200 OHM 1/4W 5% CARBON	3070622	1121
R827	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R828	POTENTIOMETER, 2K OHM PC TRIM	3110138	70488
R830	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R831	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
S100	SWITCH, TOGGLE SPDT	2600103	100885
S101	SWITCH, SLIDE	2600323	10597
S200	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
S330	SWITCH, ROTARY	2600331	10597
S520	SWITCH, PUSH BUTTON	2600318	10597
S700	SWITCH, ROTARY	2600329	10597
S740	SWITCH, PUSH BUTTON	2600332	10597
S750	SWITCH, ROTARY	2600329	10597
S790	SWITCH, PUSH BUTTON	2600332	10597
T100	TRANSFORMER, POWER	1200039	10597

PART	DESCRIPTION	EXACT NO	MFG
C283	CAPACITOR, 0.05 MFD 50 VOLT	2900052	10597
C950	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C951	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C952	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C955	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C956	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C957	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
D950	DIODE, 1N751A	1520751	75042
D955	DIODE, 1N751A	1520751	75042
J985	CONNECTOR, BNC	1310047	91836
Q950	TRANSISTOR, 2N2219	1562219	1295
Q955	TRANSISTOR, 2N2905	1562905	1295
Q960	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q970	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q975	INTEGRATED CIRCUIT, SN76502N	1580030	1295
Q980	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q985	OPERATIONAL AMPLIFIER, UA741	1580010	7263
R265	RESISTOR, 806 OHM MATCHED PAIR	3128060	10597
R950	RESISTOR, 1000 OHM 1% METAL FILM	3131001	7115
R951	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391	1121
R952	RESISTOR, 649 OHM 1/4W 1% METAL FILM	3136490	7115
R953	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221	1121
R955	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R956	RESISTOR, 560 OHM 1/4W 5% CARBON	3070561	1121
R957	RESISTOR, 649 OHM 1/4W 1% METAL FILM	3136490	7115
R958	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301	1121
R960	RESISTOR, 36500 OHM 1/4W 1% METAL FILM	3133652	7115
R961	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R962	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R963	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R964	RESISTOR, 36500 OHM 1/4W 1% METAL FILM	3133652	7115
R965	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R966	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R967	POTENTIOMETER, 2.5K OHM TRIM	3110148	71450
R970	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R971	RESISTOR, 910 OHM 1/4W 5% CARBON	3070911	1121
R972	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R973	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R974	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R975	RESISTOR, 15000 OHM 1/4W 1% METAL FILM	3131502	7115
R976	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511	1121
R977	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R980	RESISTOR, 3920 OHM 1/4W 1% METAL FILM	3133921	7115
R981	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R982	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R983	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R985	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R986	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R987	RESISTOR, 12K OHM 1/4W 5% CARBON	3070123	1121
R988	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
S710	SWITCH, LEVER 2P3T	2600308	10597
S710	SWITCH, LEVER 2P3T	2600308	10597

SECTION 6

PARTS OVERLAY

AND

SCHEMATICS

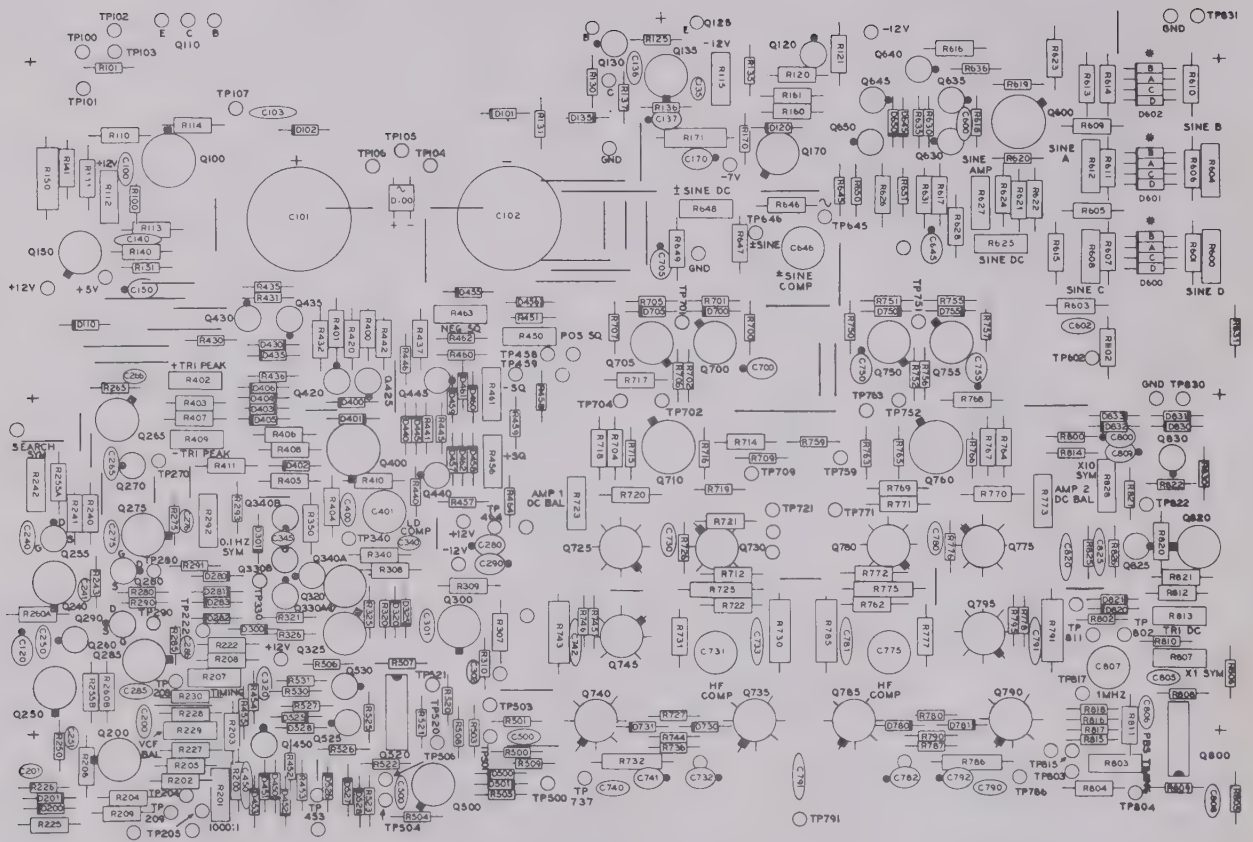
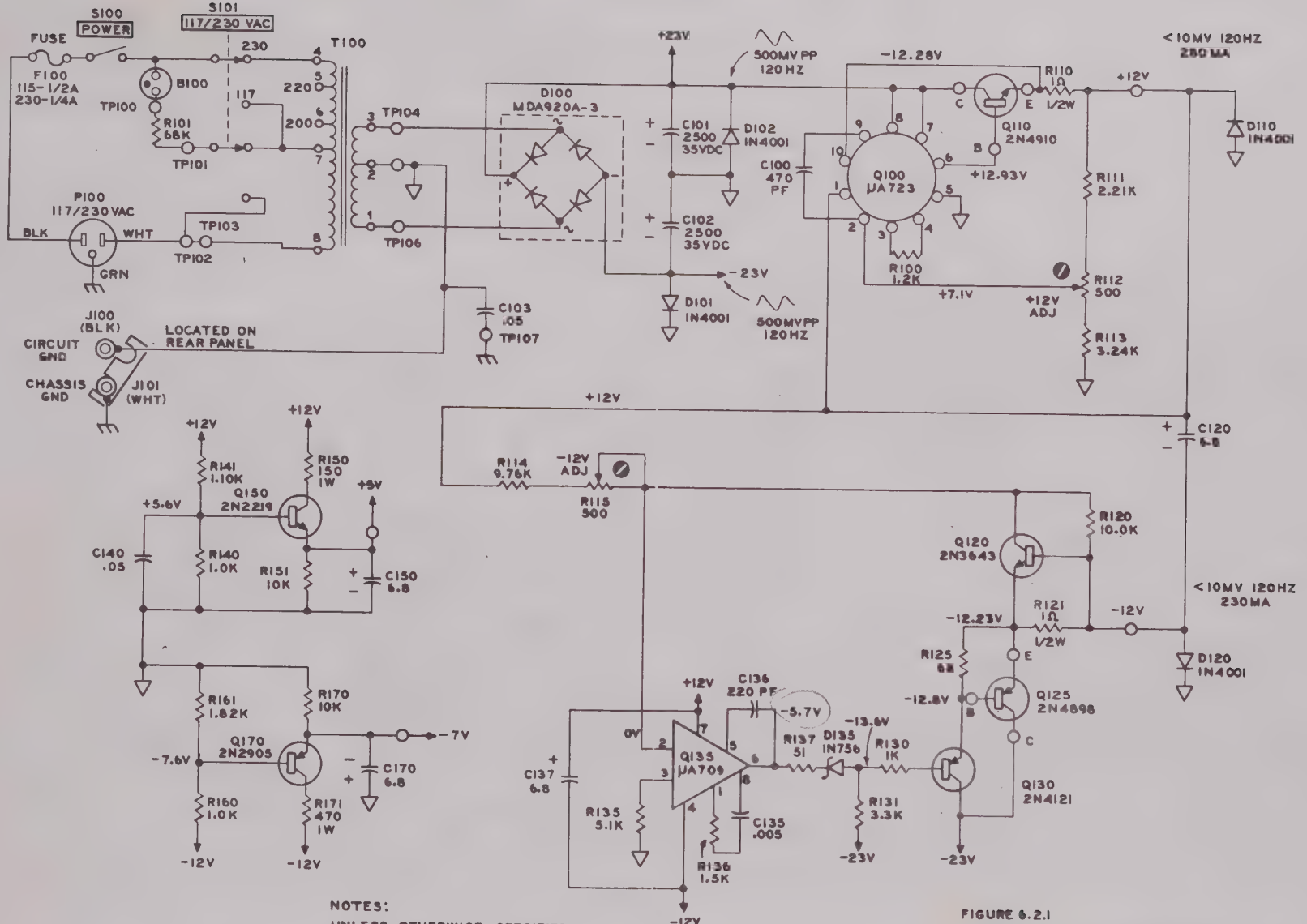


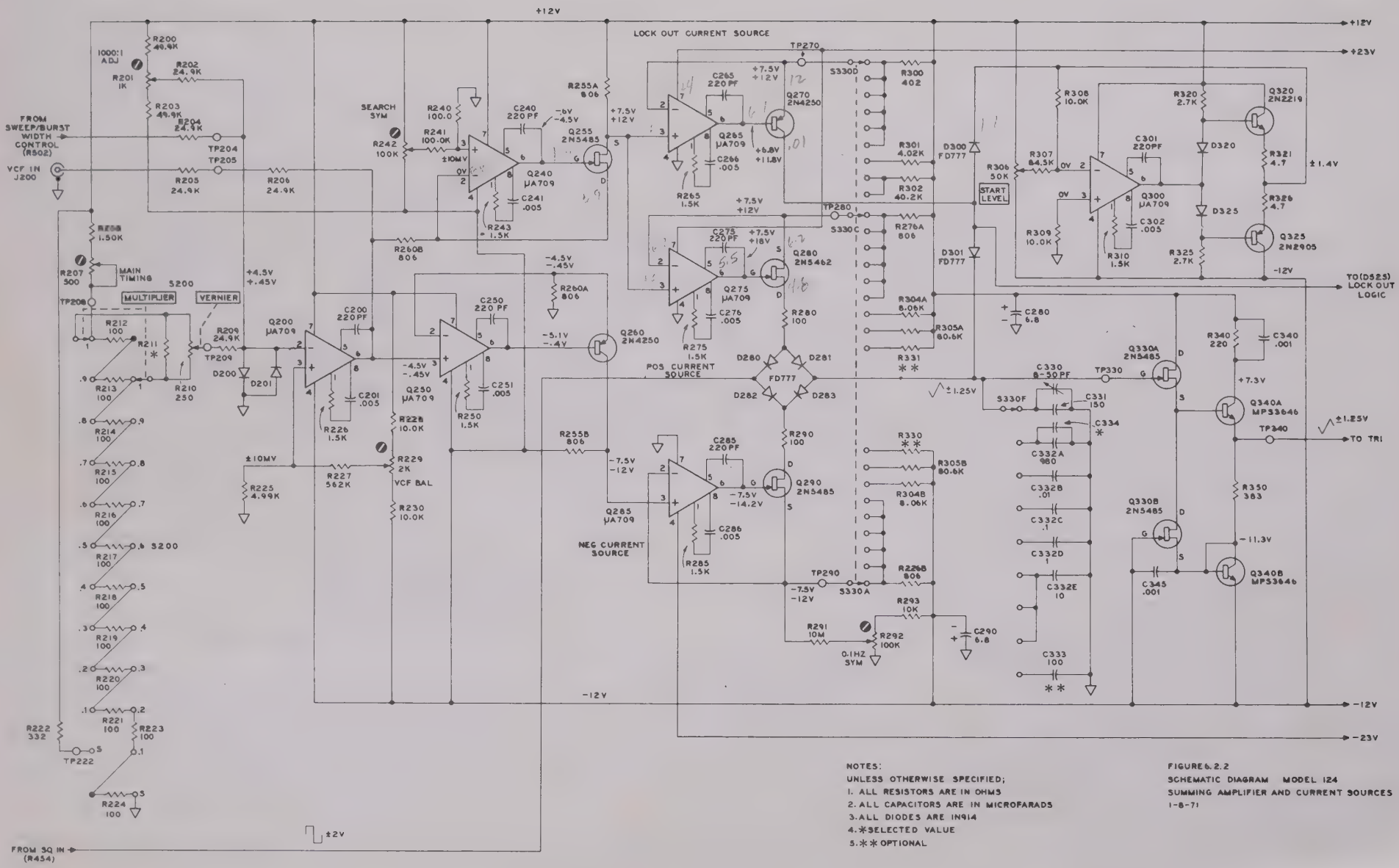
Figure 6.2.0 PARTS OVERLAY, Model 124



NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2 ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS

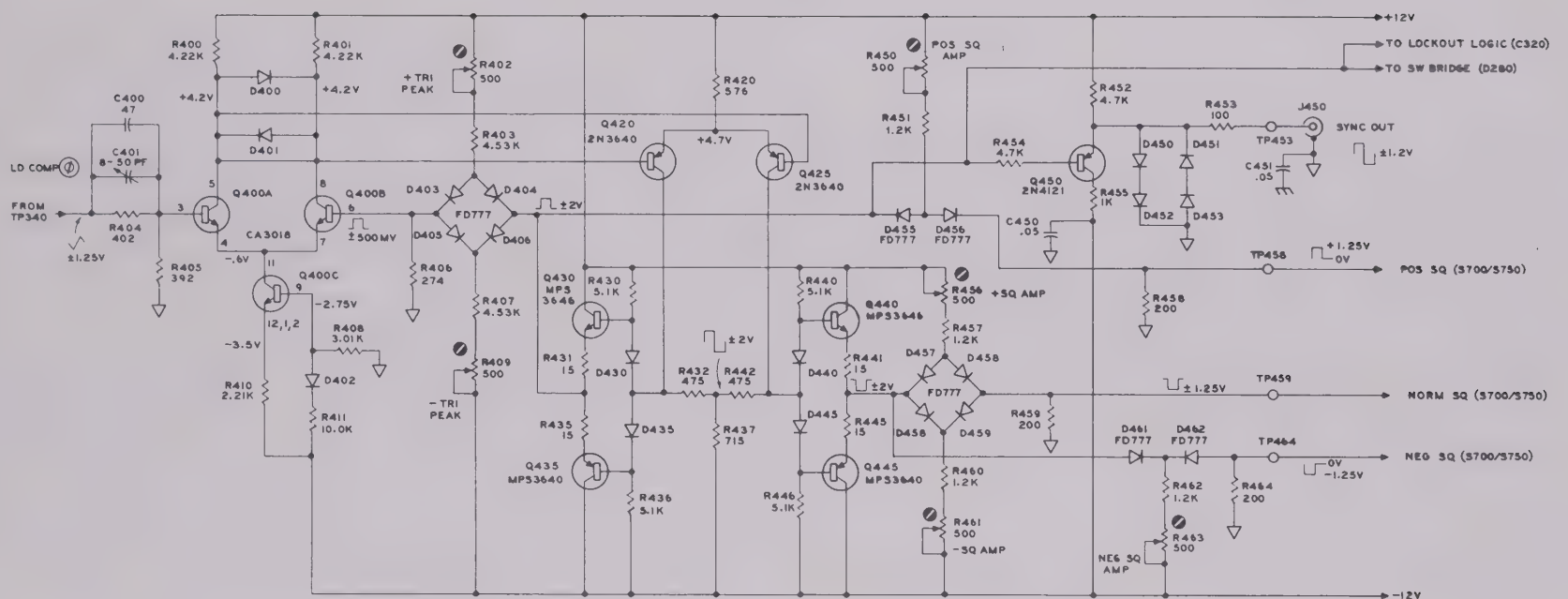
4. ▽ CIRCUIT GND
5. ⏚ CHASSIS GND

FIGURE 6.2.1
SCHEMATIC DIAGRAM MODEL 124
POWER SUPPLY
1-8-71



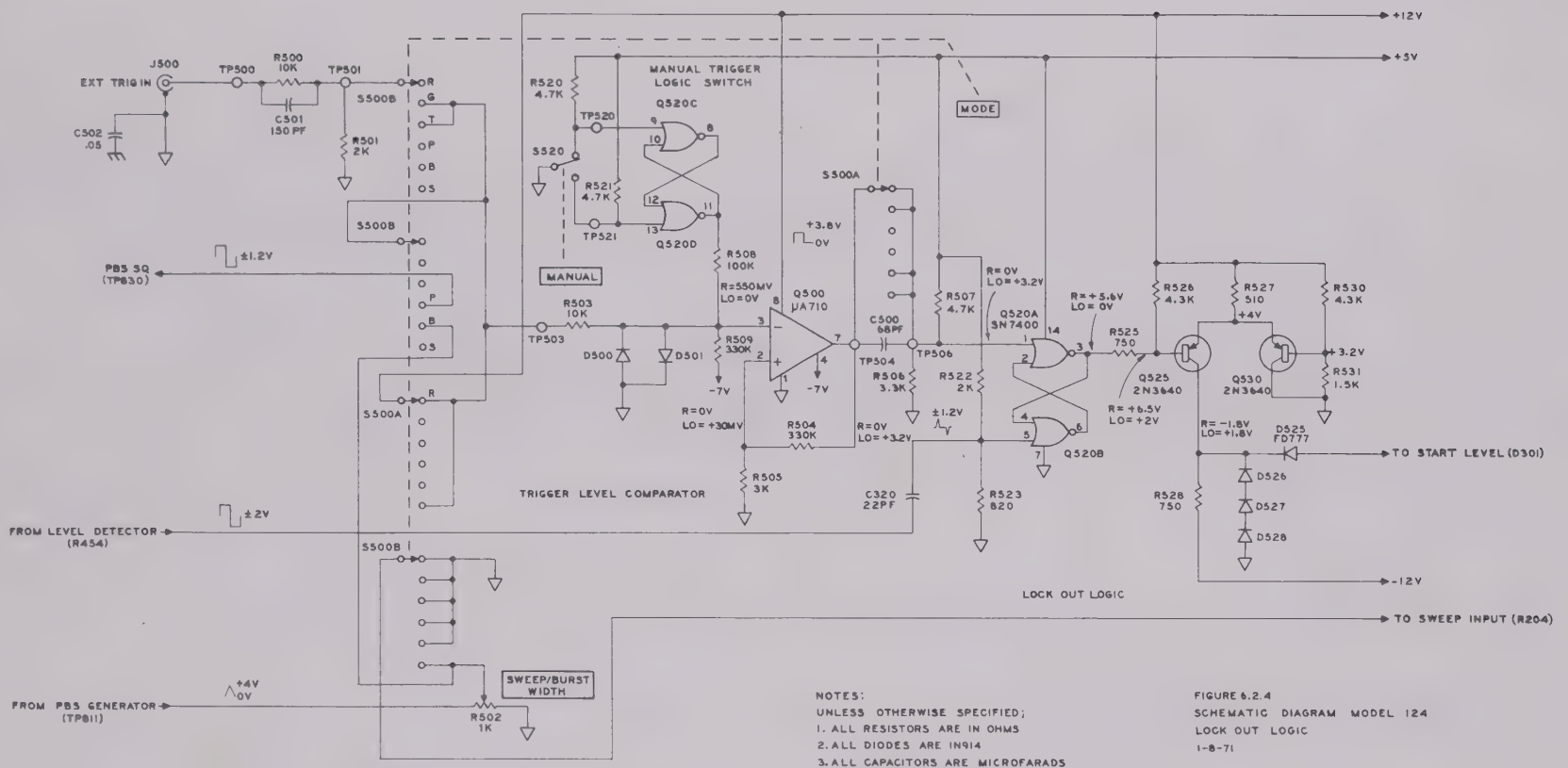
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE IN914
4. * SELECTED VALUE
5. ** OPTIONAL

FIGURE 6.2.2
SCHEMATIC DIAGRAM MODEL 124
SUMMING AMPLIFIER AND CURRENT SOURCES
1-8-71



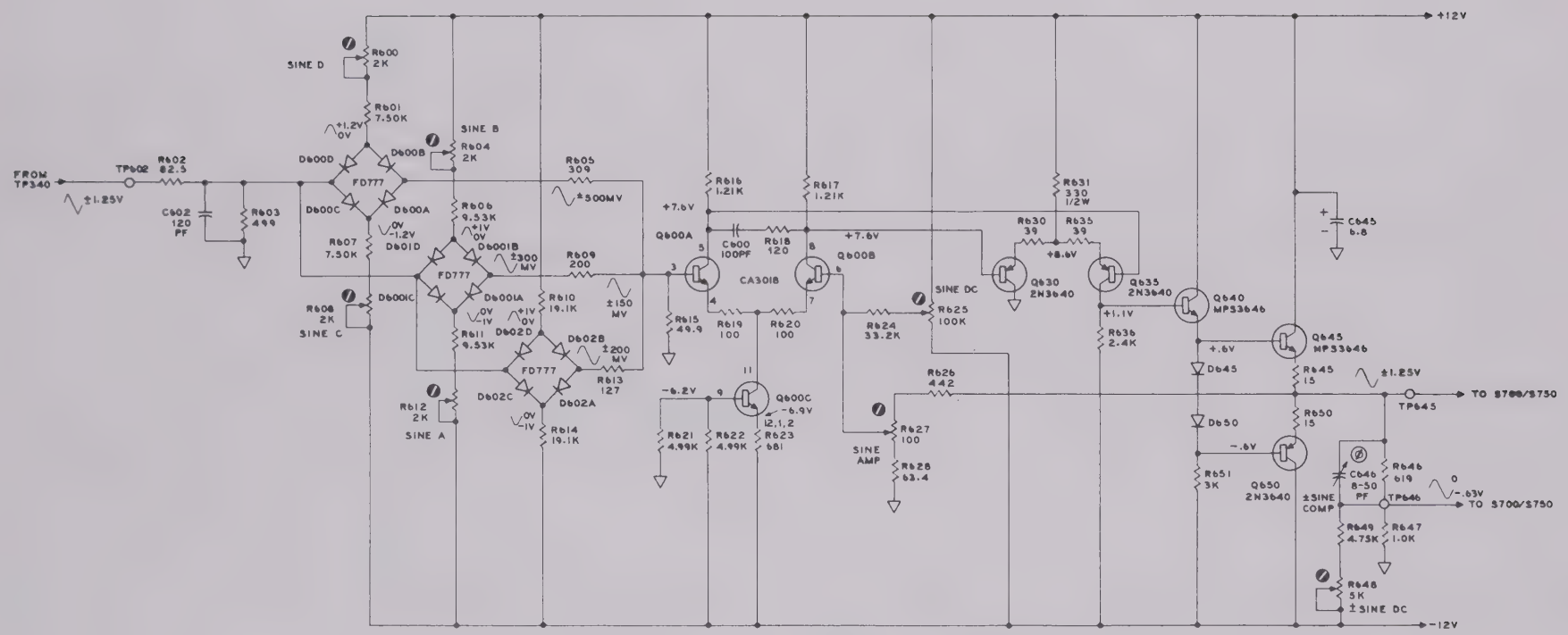
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS
4. ⏚ CIRCUIT GND

FIGURE 6.2.3
SCHEMATIC DIAGRAM - MODEL 124
LEVEL DETECTOR/BISTABLE SWITCH
1-8-71



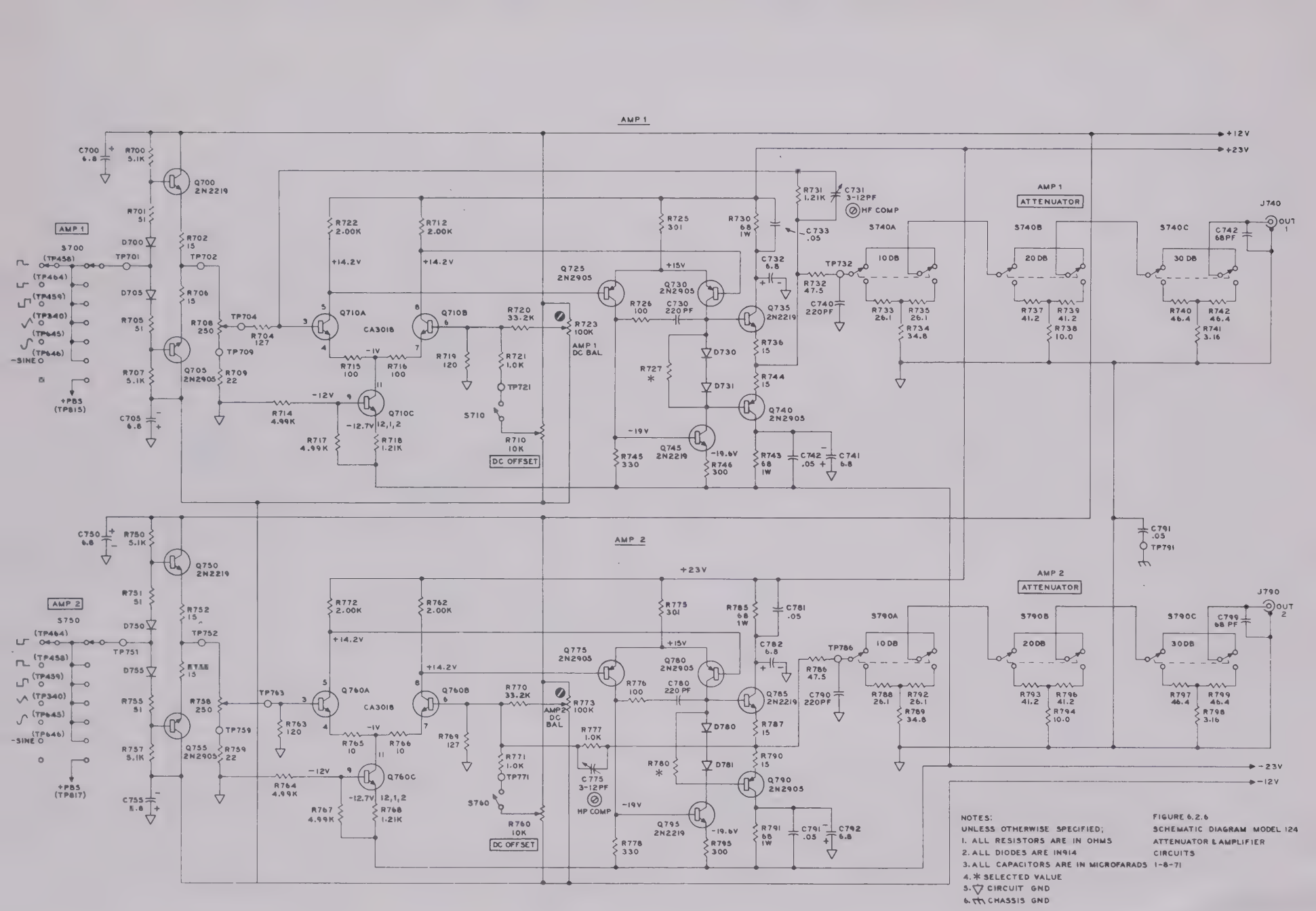
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE MICROFARADS
4. ⏚ CIRCUIT GND
5. ⏚ CHASSIS GND

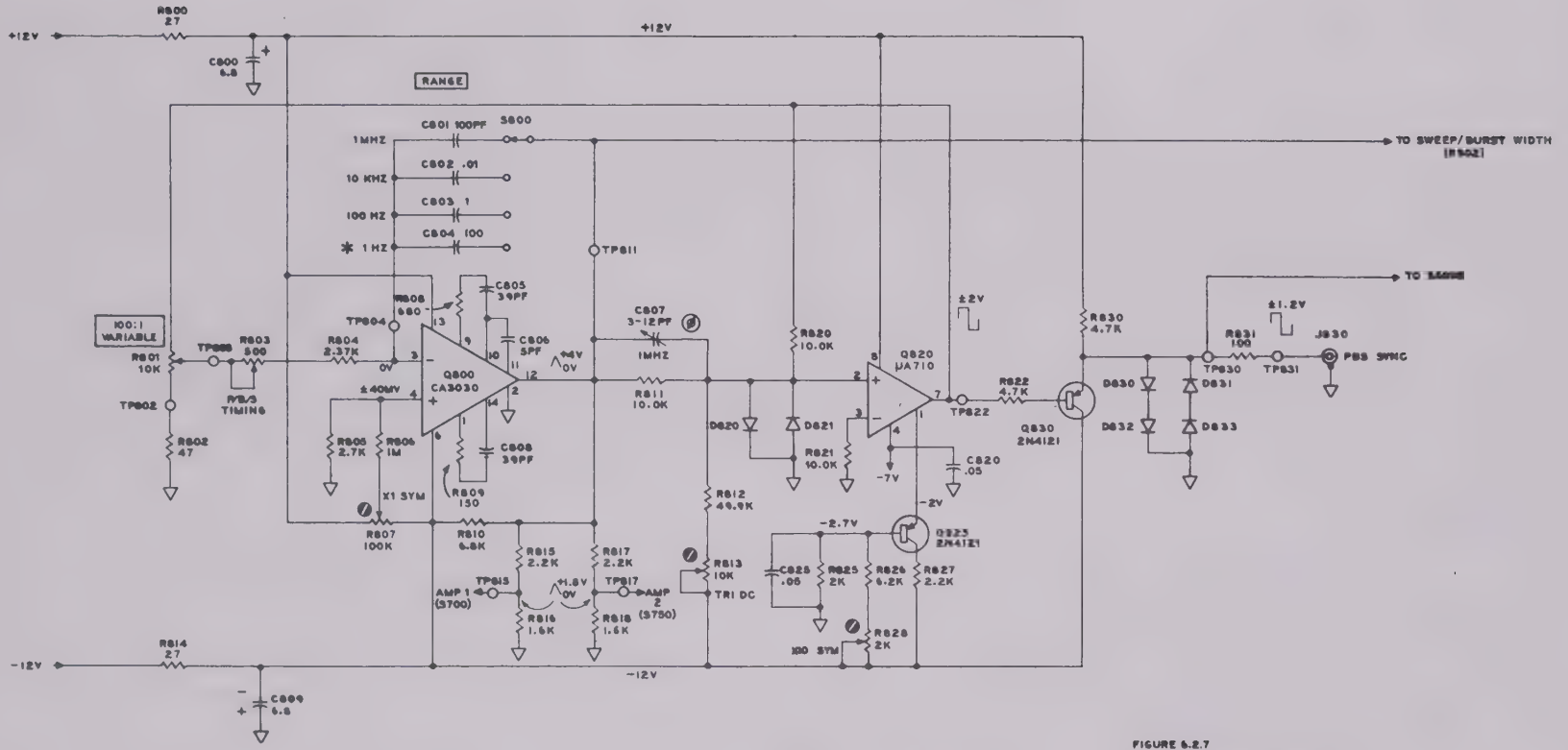
FIGURE 6.2.4
SCHEMATIC DIAGRAM MODEL 124
LOCK OUT LOGIC
1-8-71



NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS
4. ⏚ CIRCUIT GND

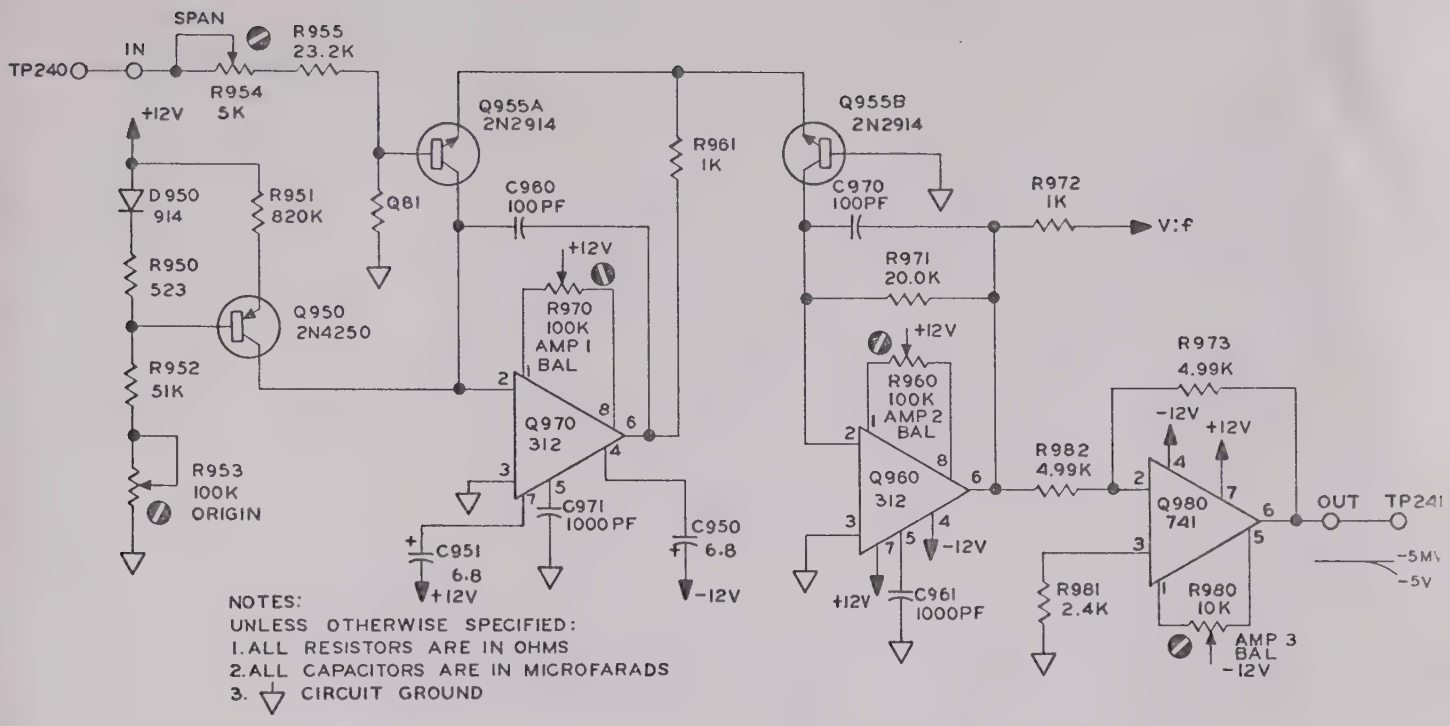
FIGURE 6.2.5
SCHEMATIC DIAGRAM MODEL 124
SINE SHAPER / SINE AMP CIRCUITS
1-8-71


AMP 1
AMP 2
+12V
+23V
-23V
-12V
AMP 1 ATTENUATOR
AMP 2 ATTENUATOR
J740
J790
OUT 1
OUT 2
S740A
S740B
S740C
S790A
S790B
S790C
10 DB
20 DB
30 DB
HF COMP
MF COMP
AMP 1 DC BAL
AMP 2 DC BAL
DC OFFSET
CA3018
Q710A
Q710B
Q710C
Q760A
Q760B
Q760C
S700
S750
S710
S760
TP701
TP702
TP704
TP709
TP721
TP732
TP751
TP752
TP759
TP763
TP771
TP786
TP791
+PBS (TP815)
+PBS (TP817)
-SINE
(TP458)
(TP464)
(TP459)
(TP340)
(TP643)
(TP646)
R700 5.1K
R701 51
R702 15
R705 51
R706 15
R707 5.1K
R708 250
R709 22
R712 2.00K
R714 4.99K
R715 100
R716 100
R717 4.99K
R718 1.21K
R719 120
R720 33.2K
R721 1.0K
R722 2.00K
R723 100K
R725 301
R726 100
R727 *
R730 68 1W
R731 1.21K
R732 47.5
R733 26.1
R734 34.8
R735 26.1
R736 15
R737 41.2
R738 10.0
R739 41.2
R740 46.4
R741 3.16
R742 46.4
R743 68 1W
R744 15
R745 330
R746 300
R750 5.1K
R751 51
R752 15
R755 51
R756 250
R757 5.1K
R759 22
R762 2.00K
R763 120
R764 4.99K
R765 10
R766 10
R767 4.99K
R768 1.21K
R769 127
R770 33.2K
R771 1.0K
R772 2.00K
R773 100K
R775 301
R776 100
R777 1.0K
R778 330
R780 *
R785 68 1W
R786 47.5
R787 15
R788 26.1
R789 34.8
R790 15
R791 68 1W
R792 26.1
R793 41.2
R794 10.0
R795 300
R796 41.2
R797 46.4
R798 3.16
R799 46.4
C700 6.8
C705 6.8
C730 220 PF
C731 3-12PF
C732 6.8
C733 .05
C740 220PF
C741 6.8
C742 .05
C742 68PF
C750 6.8
C755 6.8
C775 3-12PF
C780 220 PF
C781 .05
C782 6.8
C790 220PF
C791 .05
C792 6.8
C799 68 PF
Q700 2N2219
Q705 2N2905
Q725 2N2905
Q730 2N2905
Q735 2N2219
Q740 2N2905
Q745 2N2219
Q750 2N2219
Q755 2N2905
Q775 2N2905
Q780 2N2905
Q785 2N2219
Q790 2N2905
Q795 2N2219
D700
D705
D730
D731
D750
D755
D780
D781
+14.2V
+15V
-1V
-12V
-19V
-12.7V 12,1,2
-19.6V
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS
4. * SELECTED VALUE
5. ▽ CIRCUIT GND
6. ⏥ CHASSIS GND
FIGURE 6.2.6
SCHEMATIC DIAGRAM MODEL 124
ATTENUATOR & AMPLIFIER
CIRCUITS
1-8-71



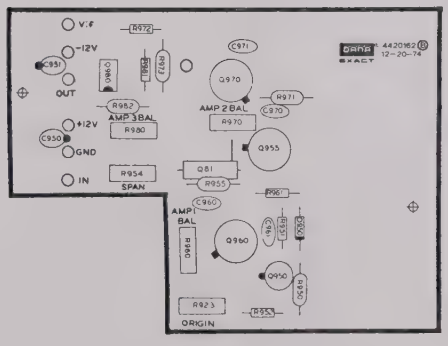
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914
3. ALL CAPACITORS ARE IN MICROFARADS
4. * SELECTED VALUE - OPTIONAL
5. ⏚ CIRCUIT GND

FIGURE 6.2.7
SCHEMATIC DIAGRAM MODEL 124-125
PULSE/BURST/SWEEP GENERATOR
10-6-71



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ⏚ CIRCUIT GROUND

SCHEMATIC DIAGRAM
LOG AMP MODEL 125,128
1-17-75 REV



SECTION 7

ADDENDA

ADDENDA

SCHEMATIC 4 (Figure 6.2.4)

R501 has been changed from a 2k to a 3.9k.

REV. A
MODEL 124
S/N 5562 and up

Description of Changes:

On the manual sheet labeled, "Figure 6.2.0 parts overlay, Model 124," there are actually two components labeled as D528. The component labeled as such, and located next and parallel to D525, is actually R528. The correct D528 is located next and parallel to R523.

On the schematic labeled, "Figure 6.2.4, schematic diagram Model 124, lock out logic, 1-8-71," Q520A-D is drawn as a 7402 or-gate when in actuality it's a 7400 and-gate.

On the Main Circuit Board, TP737 is identified as such on the board itself, however, on the schematic it's referred to as TP732.

Error in drawing. Drawing of transformer on power supply page shows instrument wired to pin 4 (230V TAP), should show pin 5 (220V TAP).

February 19, 1974

ADDENDUM
Models 124 and 125

R420 was 576Ω is now 536Ω
R501 was 3.9K is now 6.8K
R504 was 330K is now 82K
C805 was 39pf is now 22pf
C808 was 39pf is now 22pf
R816 was 1.6K is now 1.8K
R818 was 1.6K is now 2K
R508 was 100K is now 56K
R646 was 619Ω is now 309Ω
R647 was 1.00K is now 442Ω
R649 was 4.75K is now 2.00K
R648 was 5K is now 2K
Add C647 across C646 (47pf Mica cap)
R700 was 5.1K is now 5.11K
R707 was 5.1K is now 5.11K
R750 was 5.1K is now 5.11K
D700 was 1N914 is now D700A Matched
D705 was 1N914 is now D700B Matched
D750 was 1N914 is now D750A Matched
D755 was 1N914 is now D750B Matched
R235 from 332Ω 1% 1/4W to 301Ω 1% 1/4W
R222 from 332Ω 1% 1/4W to 301Ω 1% 1/4W

DANA EXACT ELECTRONICS, INC.
5-21-75

ADDENDA
Model 124, 125

Change R821 from 10.0K 1% 1/4w to 4.53K 1% 1/4w Resistor.

EXACT ELECTRONICS, INC.
September 16, 1975